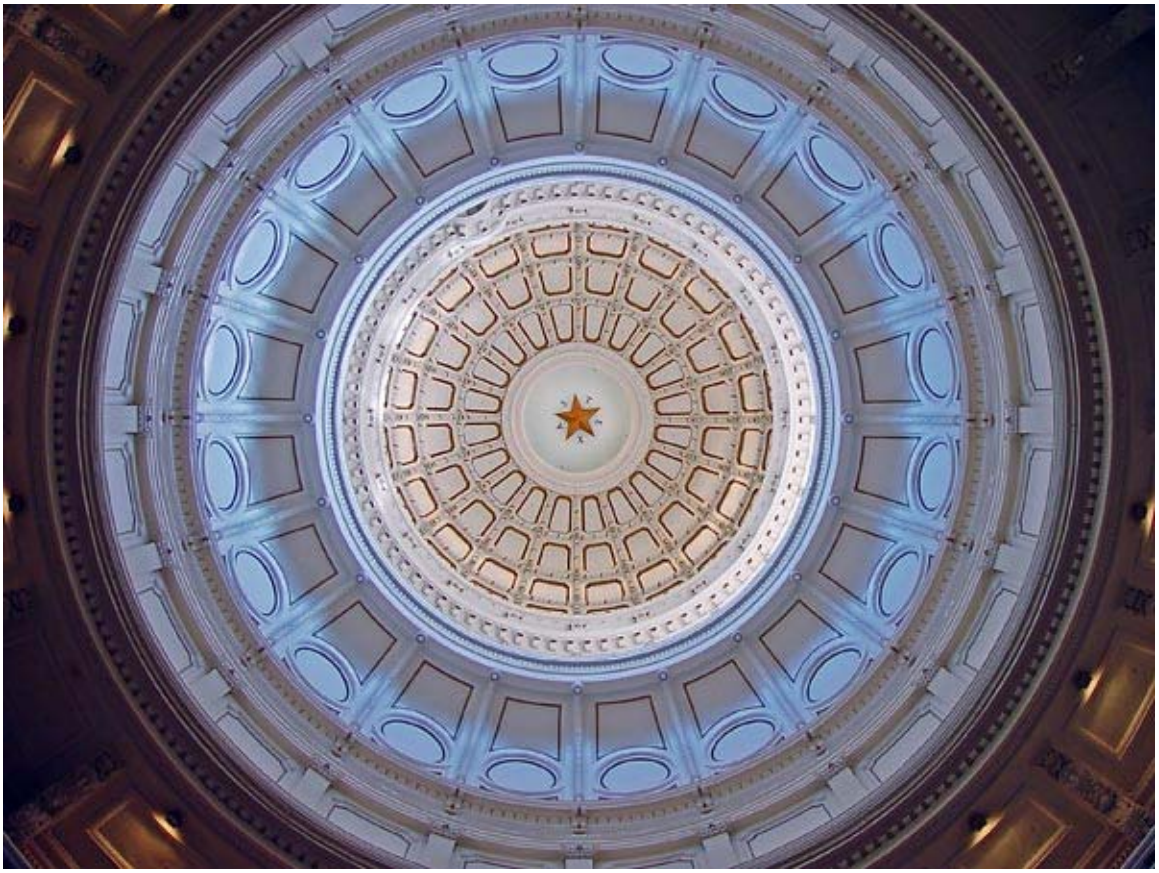
Governor's Clean Coal Technology Council of Texas

Railroad Commissioner Michael L. Williams, Chairman

Clean Coal:

The Key to Affordable Electricity in Texas



REPORT TO THE HONORABLE RICK PERRY
GOVERNOR OF TEXAS

MARCH 2005

Governor's Clean Coal Technology Council of Texas

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1. INTRODUCTION

Coal has never been more important to the Texas energy future than it is today. Texas is the number one coal consuming state in the nation, and Texas has more than a 200-year supply of coal and lignite available within its own borders. The challenge for Texas is to explore technologies that will put Texas on the leading edge of coal gasification, dramatically improving air quality while maintaining this affordable source of energy.

Regulatory agencies and elected officials in Texas recognize the urgency of securing an affordable and environmentally sound energy future for Texas.

Governor Rick Perry laid the foundation for securing Texas' energy future on December 19, 2002, when he issued an executive order creating the Governor's Clean Coal Technology Council (CCTC). (Attachment A). That single action framed the challenge facing the CCTC and Texas:

- Fuel diversity – represented by coal and lignite - is a significant factor in providing the reliable and affordable supply of energy needed to maintain the strength of the Texas economy, and the economy of this nation.

- The continued use of coal as a power source, however, is dependent on clean coal technology advancements demonstrating that electricity and other advanced fuels produced from coal can be more efficient, more economical and more environmentally friendly.

CCTC Chairman, and Texas Railroad Commissioner, Michael L. Williams led the 13-member council in responding to the Governor's charge by examining emerging clean coal technologies and by reviewing existing research and development activities. Following a year of reports, briefings and independent investigation, the CCTC identified coal gasification as one of the most promising technologies for Texas to pursue.

Coal gasification is the cleanest of all coal technologies, converting coal into a versatile gas (called syngas) that can be stripped to near-zero levels of virtually all undesirable components, including sulfur and mercury. It also provides the most economical route for capturing carbon dioxide for sequestration or for productive uses such as enhanced oil recovery. The resultant syngas from gasification can be used as a fuel for producing clean electric power and steam or as a versatile feedstock for production of hydrogen, chemicals, fertilizers, and ultra-clean transportation fuels, all of importance to Texas. Gasification can also utilize a wide variety of feedstocks and co-feedstocks, including a variety of coals, petroleum residues, biomass, and recycled waste materials.

The CCTC's work took on a heightened sense of urgency on February 27, 2003, when President George W. Bush announced a U.S. Department of Energy (DOE)-sponsored, $1 billion, 10-year initiative to build FutureGen, a coal-fueled prototype power plant of the future featuring near zero emissions. Texas is competing with at least five other states to

become the home site for FutureGen and, according to the DOE, the core of FutureGen "will be an advanced coal gasifier."

These intersecting developments provide the CCTC an opportunity to pursue its Mission Statement and to fulfill its Goals, which are:

Mission Statement: Promote the development and use of Clean Coal Technologies that will result in reliable, low cost, and environmentally responsible energy sources for Texas.

Goals:

- Form coalitions of academia, industry, local, state and federal governmental entities for the promotion of Clean Coal Technologies in the State.
- Identify Clean Coal Technologies to lower emissions and increase efficiency of new and existing generation capacity in the State.
- Evaluate the feasibility of such technologies through economic analysis and benefits to the environment.
- Aggressively seek federal and other funding in support of the Council and Clean Coal Technology projects within the State.

To promote and facilitate the above, the CCTC authorized creation of a non-profit 501(c)(6) foundation known as the "Clean Coal Technology Foundation of Texas" (Foundation). (Creation Documents, Attachment B). CCTC Vice Chairman Clifford Miercort, President of North American Coal Corporation, was instrumental in encouraging private sector members to form the Foundation and to provide staff support for the council's efforts.

Combined, the Council and the Foundation represent the state's elected officials, regulatory agencies, electric generation companies, and coal providers.

The Foundation has assisted the CCTC by initiating the state's bid for the FutureGen project, which the CCTC has designated as a priority. Public meetings have been held across the state to generate broad energy industry and community support for the state's bid for FutureGen. Members of the Texas Congressional delegation and Texas Legislature have been briefed and discussions have been initiated with the DOE. Discussions have also been initiated with industries that have experience and technology in gasification and/or have potential sites of interest for a FutureGen or gasification facility in Texas.

The CCTC's assessment of clean coal technologies and its FutureGen bid is further enhanced by a more tangible resource – a 200-year supply of coal, primarily lignite, according to the Bureau of Economic Geology (BEG), an internationally recognized research component of the University of Texas at Austin.

In short, gasification appears to be one of the most promising clean coal technologies and its further development could lead directly to making FutureGen a reality in Texas.

FutureGen's core coal gasification technology holds possible commercial applications that will both improve air quality and maintain Texas lignite as a viable energy source. And, Texas has a 200-year supply of lignite, which can be used to fuel coal gasification power generation plants, including FutureGen. In meetings during the past two years to consider how best to encourage the development of clean coal technologies such as gasification, how best to capture FutureGen for Texas, and how best to maintain the lignite industry as an energy resource, the CCTC concluded three basic areas should be pursued:

- **The approval of legislation in the 2005 session of the Texas Legislature**
- **The promotion of research and development**
- **Regulatory change**

In considering the opportunities for advancing clean coal technologies, the CCTC also examined the barriers to the investment and deployment of those technologies, particularly by electric power companies who – with more stringent environmental protection measures on the horizon – are the front-line candidates for the improved technology.

This report contains the findings of the Clean Coal Technology Council, but most importantly it recommends specific regulatory, state legislative, and research and development actions relating to clean coal technology, FutureGen and the Texas lignite industry.

Critical among these is the recommendation to formally establish the Clean Coal Technology Council to lead the state's efforts to win FutureGen and to support state legislation that would provide the funding and infrastructure necessary to support the state's bid for that DOE project.

2. EXECUTIVE SUMMARY

Coal's importance to Texas' energy picture is largely unrecognized by the general public.

Texas is the largest generator of electricity in the nation, it consumes more coal and lignite for generation of electricity than any other state, it is the nation's fifth largest coal-producing state, and coal and lignite, which is a low-grade coal, produce 37 percent of the electricity consumed in Texas.

As a direct result of coal and lignite, Texas consistently achieves some of the lowest electric rates in the United States. But despite the benefits of coal, electric power generators face new state and federal regulations to dramatically reduce emissions.

In proposing a course of action that will meet Texas' growing demand for electricity and will allow power generators to satisfy regulatory standards, the CCTC identified three core issues: clean coal technology, FutureGen, and the in-state lignite industry.

Clean Coal Technology

The DOE, U.S. Environmental Protection Agency (EPA), universities, power generating companies and the coal industry are engaged in research partnerships to develop more efficient technologies that will reduce emissions and improve efficiencies of existing and new coal-fueled electric power generating plants. The power industry also is researching new technologies to improve the capture of emissions for the various types of coal and combustion systems currently in use.

Research using technologies that involve gasification of coal appear to be the most promising. Commonly referred to as Integrated Gasification Combined Cycle (IGCC) technologies when used for power generation, these systems significantly reduce emissions to near zero levels, in particular by making it much easier to capture sulfur, mercury, and carbon dioxide emissions. They also use coal more efficiently, consume approximately 40% less water, and produce significantly less solid wastes than coal combustion processes. Research is under way on such technologies that specifically utilize lignite or combinations of lignite and other carbon-rich fuels.

The U.S. Department of Energy (DOE) regards coal gasification as "one of the most versatile and cleanest ways to convert the energy content of coal into electricity, hydrogen, and other energy forms." Pioneering coal gasification electric power plants are operating commercially in the United States and other countries, and energy experts predict coal gasification will be the centerpiece of future generations of clean coal technology power plants such as FutureGen.

Coal gasification is being evaluated as a viable option to help meet the future demand for energy. Gasification is a commercially ready and available technology waiting for broader deployment, particularly for electric power generation. When gasification technology is deployed, it will be capable of meeting stringent environmental regulations, will utilize our greatest domestic fuel resource, and will greatly expand the uses of coal and lignite in the energy system.

In addition to the advantages gasification technologies create by producing electricity more efficiently and cleanly, they are also being evaluated for their potential to produce hydrogen for refineries, for the automobiles of tomorrow, and for future power-generating fuel cells. This production of hydrogen forms the basis for the concept of FutureGen and, if proven feasible, will guarantee a substantial future role for coal in providing the nation's energy.

The syngas produced from coal gasification technology is very clean and very versatile. In addition to power and hydrogen production, syngas can be used to produce a wide variety of chemicals, fertilizers, and ultra-clean transportation fuels. All of these applications are of importance to the state of Texas and have been commercially demonstrated.

The first commercial use of coal gasification in the United States was in 1983 to make chemicals from coal at Eastman Chemical Company's Kingsport, Tennessee facility. The first major use of coal gasification to generate electric power in the United States occurred in the mid-1980s in Barstow, California. That 100-megawatt plant established the early technical foundation for future IGCC power plants.

Gasification is capable of removing virtually all of coal's pollution-forming impurities, according to the DOE, and when burned in a gas turbine its environmental performance can rival natural gas.

The two coal gasification power generating plants currently operating commercially in the United States are:

- Tampa Electric's Polk Power Station –The nation's first "greenfield" (built as a completely new plant) commercial integrated gasification combined cycle power station, the Mulberry, Fla. plant can generate 313 gross megawatts of electricity (250-260 MW net). According to the DOE, the plant's gas cleaning technology:
    - Removes more than 98 percent of the sulfur in coal, converting it to a commercial product.
    - Reduces nitrogen oxide emissions by more than 90 percent.
- The Wabash River Repowering Plant – Started full operations in late 1995 near West Terre Haute, Indiana as the first full-size commercial dual-stage gasification-combined cycle plant built in the United States and is noteworthy because:
  Generating 262 net megawatts of electricity, it remains one of the world's largest single train gasification combined cycle plants operating commercially, according to the DOE.

- The sulfur dioxide capture efficiency exceeds 99 percent.
- Particulate emissions are below detectable limits.
- Carbon monoxide emissions are well below industry standards.

Eastman Chemical Company's coal gasification facility for production of chemicals has been in continuous operation for over 21 years. This plant is noteworthy because it has:

- Outstanding operating performance, with 98-99% on-stream availability and 1-2% forced outage rate (88-90% single-train availability).
- Essentially complete volatile mercury removal from its syngas.
- Over 99.9% demonstrated sulfur removal capability, including a sulfur-free startup process.
- Highest production rate of syngas per unit of gasifier volume of any commercial GE-type coal gasifier.
- Carbon dioxide capture as a concentrated stream (has been sold as a commercial product).

Dakota Gasification Company's Great Plains Synfuels Plant has been in operation since 1984 near Beulah, North Dakota. This plant is unique in that it:

- Produces 54 Bscf per year of synthetic natural gas (methane) that is placed directly into natural gas pipelines, as well as producing a mixture of other chemical and fertilizer products.
- Captures carbon dioxide which is piped 200 miles north to Canada where it is used for enhanced oil recovery.
- Uses lignite as its primary feedstock.

In developing this report, CCTC Chairman Williams challenged members to identify barriers to widespread commercial use of clean coal technologies and to explore ways for Texas government and power companies to spur deployment of these technologies. Those barriers include:

- Difficulty selling clean electricity at competitive prices
- Inability to recover technology investment
- Delay in capital investments by power generators until emissions and mercury requirements become more specific
- Cost of advanced gasifiers
- Transport, removal of solids
- Carbon dioxide capture capability
- Advanced gasifier designs targeted to use lignite, and/or pretreatment or cofeeding of lignites to enable them to be used in conventional gasifiers

This report recommends solutions for a number of these barriers and the DOE has research and development programs in place to resolve the technical questions.

FutureGen

The Integrated Sequestration and Hydrogen Research Initiative, commonly known as FutureGen, is a component of the Vision 21 program within the DOE's Office of Fossil Energy. The $1 billion dollar project is intended to create the world's first zero-emissions fossil fuel plant and to sequester at least one million tons per year of carbon dioxide. The program combines industry investments and federal and international funds to research, develop and demonstrate advanced clean coal technologies.

FutureGen will employ coal gasification technology integrated with combined cycle electricity generation and the sequestration of carbon dioxide emissions, according to DOE. It will take clean coal technology to a more advanced level by establishing the technical and economic feasibility of:

- Producing near zero-emissions electricity from coal, which DOE describes as "the lowest cost and most abundant domestic energy resource."
- Producing hydrogen for the secondary market.
- Capturing and permanently storing carbon dioxide (CO_2) for other uses such as enhanced oil recovery (EOR).

"When operational, the prototype will be the cleanest fossil fuel fired power plant in the world," according to DOE, adding the $1 billion public/private partnership will focus "on the design, construction and operation of a technically cutting-edge power plant that is intended to eliminate environmental concerns associated with coal utilization."

Coal gasification, and by extension FutureGen, offers both economic and environmental benefits for coal-based electric power generating companies and their customers.

"Coal's abundance in the United States makes finding clean ways to use it among our highest priorities. Coal gasification, when combined with carbon sequestration, has the potential to revolutionize energy production," according to William K. Reilly, former EPA administrator and National Policy on Energy Commission co-chairman.

For the last 25 years, the DOE has seen U.S. power generators looking increasingly to new pollution control technologies to meet more stringent clean air and water regulations. FutureGen represents the next step in this technology progression in tighter regulatory standards.

The Texas Commission on Environmental Quality (TCEQ) recently implemented new limits for NO_x emissions from power plants, resulting in Texas electric generators installing more than $1 billion in additional control equipment between 2000 and May 2005.

President Bush's Clear Skies Initiative announced in 2003 proposes further reductions in emissions from coal-fueled electric generating plants:

- Sulfur dioxide emissions would be cut by 73 percent, from current emissions of 11 million tons to a cap of 4.5 million tons in 2010, and a maximum of 3 million tons in 2018.

- Nitrogen oxide (NOx) emissions would be reduced by 67 percent from current emissions of 5 million tons to a cap of 2.1 million tons in 2008 and 1.7 million tons in 2018.

- Mercury emissions – which have never been regulated for power plants – would be cut by 69 percent, from the current 48 million tons to a cap of 26 tons in 2010 and 15 tons in 2018. No technology has yet been demonstrated to achieve the level of mercury emissions from lignite-fired plants that EPA is proposing, however, gasification has demonstrated significant achievements in mercury removal from other coals and is expected to produce similar results with lignites.

FutureGen, its coal gasification technology, and additional clean coal technology research appear to hold the key to developing energy independence, protecting air quality and addressing environmental and economic issues related to coal-fueled electric power production.

Texas Coal and Lignite

Texas has an appreciable quantity of low- to medium-grade bituminous coal, according to The Handbook of Texas, and a large quantity of average- to high-grade lignite.

Almost all, 99 percent of the 48.18 million tons of lignite mined in Texas is used to generate electricity for the Texas market. The balance of Texas coal consumption, which is about 55 percent, or 51.14 million tons, is imported, primarily from Wyoming. Between 1989 and 2002, the share of Texas lignite supplying the Texas market decline from 59 percent to 45 percent while coal from Wyoming, Colorado and Utah increased from 41 percent to 55 percent.

Despite the fact Texas is the fifth largest producer of coal and lignite in the United States, has a 200-year recoverable supply of this natural resource, and consumes more coal and lignite than any other state, no new coal fired capacity has been brought on line in Texas since 1992. However, the low and stable cost of coal and lignite makes coal-fueled plants less expensive to run from a fuel source standpoint, especially with today's natural gas markets.

During these decades, population and the demand for electricity have grown dramatically, coal has proven to be a low-cost, reliable energy source, and volatile, rapidly escalating natural gas prices have significantly driven up the electric bills of many consumers.

If electricity demand increases as expected and coal and lignite remain the source of 37 percent of the electricity produced in Texas, then the amount of coal and lignite required will also grow. If this demand were satisfied by Texas coal and lignite, the number of tons used as

fuel in electric generating plants annually would increase to more than 60 million tons by 2015.

Environmental concerns over air quality are largely responsible for the absence of new coal-based power plants, but emerging technologies are expected to solve many of those problems. Although research is ongoing and pilot projects are operating, questions of cost and reliability must be answered before power generating companies are willing to invest the money necessary to deploy clean coal technologies on a widespread, commercial basis.

Universities, the state and federal governments, coal companies, and energy producers all have a role to play in maintaining Texas' existing coal and lignite industry while making plans to replace older coal and lignite plants with cleaner coal and lignite plants.

North Dakota can serve as example of how to preserve an existing lignite industry and how to promote further development. Lignite produces 90 percent of that state's electricity, creates 22,000 direct and indirect jobs, generates more than $1.7 billion of business volume, and puts $75 million in the state tax coffers each year.

Cognizant of North Dakota's 800-year supply of lignite, the state's tax and regulatory policies, along with the funding of research and development projects, are very important to the industry. For example, a 10-cent per ton severance tax produces $3 million annually to fund an industry/government research and development partnership. Every state dollar invested has resulted in a $5 industry match.

Researchers at the Energy and Environmental Research Center (EERC) at the University of North Dakota note that while feasibility tests continue, lignite's performance as a fuel source for gasification power plants is promising for several reasons:

- High reactivity – Lignite gasifies easily, requiring lower temperatures to convert its carbon to energy and producing conversion efficiencies of nearly 100 percent.

- Moisture content – The steam produced from lignite's elevated moisture content boosts the bulk gas flowing to a plant's power turbines.

- Low cost – Lignite offers the lowest cost for getting BTUs into a power plant.

3. THE PATH FORWARD

The Clean Coal Technology Council has outlined the importance of clean coal technology, FutureGen and the in-state lignite industry in efforts to promote affordable electricity for Texas consumers.

Facilitating the construction of clean coal projects, including FutureGen, at new or existing electric generating, steam production, or industrial products facilities is in the best interest of all Texans. The construction of clean coal projects will place Texas in a better position to compete for FutureGen.

State agencies and departments can play a role by facilitating the financing, construction and operation of clean coal projects, including FutureGen, by streamlining regulatory and permitting processes. Streamlined regulatory procedures are necessary to ensure predictability and to improve the state's position for federal funding and private investment in these projects. None of these proposals loosen state or federal environmental protections or restrict public participation.

The CCTC has determined that legislative and regulatory changes and additional research and development should be pursued in order to advance each of these core issues. This includes:

Clean Coal Technology

The mandate of the Clean Coal Technology Council should be reauthorized and expanded to support implementation of clean coal and related technologies, including FutureGen, incorporate research and development, provide public outreach, and support new and existing lignite and coal-fueled projects.

Federal funding, grants and other resources should be pursued in order to establish a CCTC fund to provide grants for universities and the energy industry to research, develop and implement clean coal technologies.

<u>Legislative</u>

- Adequately define "clean coal technology" to make it clear which projects qualify for the streamlined permitting process contained in proposed legislation. (legislation attached)

- Consolidate at RRC the issuance of injection well permits for both carbon dioxide EOR and carbon dioxide sequestration. (legislation attached)

- Support passage of the Federal Energy Bill that includes expanded coal research and development programs, continued support of the Clean Coal Power Initiative,

and a variety of tax and other incentives to construct new or retrofit existing power generation plants using clean coal technology.

Regulatory

- Clarify the authority of the Texas Commission on Environmental Quality (TCEQ) to expedite water rights amendments that are intended to meet the demands of clean coal projects.

- Direct the Texas Water Development Board (TWDB) to adopt procedural rules that allow the maximum flexibility in amending regional and state water plans to meet the demands of clean coal projects.

- Direct the TCEQ to adopt a general water discharge permit for clean coal projects, which will streamline and shorten the process while maintaining extensive public participation.

Research and Development

The DOE's Office of Fossil Energy is developing a portfolio of research data and clean coal technologies that could provide an avenue for power generating operators to meet the Clear Skies Initiative at the lowest possible cost to ratepayers.

The DOE lists the primary focus as developing innovative concepts that can be retrofitted to the roughly 320,000 megawatts of existing baseload coal-fueled generating capacity in the United States, which accounts for about 50 percent of the nation's electricity.

The major research opportunities for retrofit of existing facilities include:

- Advanced nitrogen oxide (NOx) controls including:
    - Low-NOx burners and reburning systems that limit NOx formation in the combustion process
    - Chemical process to clean NOx already formed from the flue gases of coal combustors
    - Oxygen-enhanced combustion that displaces part of the nitrogen-laden air in a low-NOx combustor with oxygen.

- Mercury controls that use agents to transform gaseous mercury resulting from coal combustion into solids that can be captured and agents that work inside gas scrubbers to capture mercury in the sulfate byproduct.

- Particulate controls such as fabric filters, electrostatic precipitators, or hybrids of both devices that can meet new National Ambient Air Quality Standards by capturing microscopic particles called "PM2.5," which stands for particles as

small as 2.5 microns or 0.0001 inches in diameter, which is roughly 1/30th the width of a human hair.

- Coal utilization byproduct research to develop ways to increase the recycling, including expanded commercial use, of carbon and other power plant wastes that must otherwise be disposed of.

- Water management research to develop more efficient technologies to reuse power generating plant cooling and other process water, and to improve the understanding of the chemical and physical characteristics of mine pools and watersheds that surround coal-fueled power generating plants.

In addition to these research programs aimed at reducing emissions from existing coal-fueled power generation plants, the DOE is supporting significant research programs aimed at developing advanced new clean coal technologies, particularly gasification and related technologies.

FutureGen

The DOE ranks coal gasification as "one of the most promising technologies for the energy plants of tomorrow" because of its "capability to produce electricity, hydrogen, chemicals, or various combinations while virtually eliminating air pollutants" and CO_2 emissions. Consequently, FutureGen will use coal gasification technology, which continues to develop.

Opportunities to enhance Texas' competitive bid for FutureGen include:

<u>Legislative</u>

- Adequately define "FutureGen," tying it directly to use of that term in the DOE Integrated Sequestration and Hydrogen Research Initiative, to make it clear the project qualifies for the streamlined permitting process contained in proposed legislation.

<u>Regulatory</u>

- To the extent authorized by federal law, the TCEQ shall use the standard permit as the permitting mechanism for air emissions from FutureGen/clean coal projects and the TCEQ will be further directed to ensure that these projects will trigger "new source review" only when required by federal law.

Research and Development

The DOE's Office of Fossil Energy has turned its attention to future gasification concepts that offer significant improvements in efficiency, fuel flexibility, reliability, economics and environmental performance, including:

- Investigation of new gasifier configurations that can adapt to variances in fuels (biomass, municipal/industrial waste), heating values, and ash content.

- Development of a potentially low-cost configuration for a future gasifier, called the "transport reactor integrated gasifier," or TRIG. A public/private collaboration is under way at the DOE's Power Systems Development Facility in Wilsonville, Ala.

- Development of lower-cost ways to produce the oxygen used in the gasification process.

- Development of membranes to selectively remove hydrogen from syngas for use as a fuel in fuel cells or for refineries or as gasoline substitute for hydrogen-powered cars.

- Research into new types of pollutant-capturing sorbents that will work at the elevated temperatures of hot syngases exiting a gasifier without breaking down.

- Expand commercial uses of slag produced by coal gasifiers.

- Improve fuel use efficiency to as much as 60 percent, nearly twice today's typical coal combustion plant, by incorporating fuel cells or fuel cell-gas turbine hybrids for power generation. If any of the remaining waste heat could be channeled into steam or heat, for nearby factories or heating plants, future gasification plants could reach 80 percent efficiency.

Lignite Industry

In order for the clean coal projects or FutureGen to secure an adequate supply of Texas lignite, a new or expanded mine permit will be required from the Railroad Commission of Texas (RRC).

Research and Development

North Dakota, another state with large lignite reserves, has invested public funds to maximize the natural resource in a way that Texas has not. Texas lignite's physical and chemical attributes, according to researchers at the Energy and Environmental Resource Center (EERC) at the University of North Dakota, make it an ideal fuel source for coal gasification and a worthy candidate for further research.

Texas lignite research and development projects identified by the EERC that could involve a consortium of Texas universities, energy companies and the DOE include:

- Test the performance of Texas lignites in a pilot-scale gasifier to determine conversion efficiency of the lignite to a fuel gas for firing in a turbine or a synthesis gas for the production of chemicals, with an emphasis on hydrogen production, quality of fuel gas (heating value), operational impacts of Texas lignites (ash or slag plugging), operational impacts of lignite pretreatment techniques or cofeeding techniques, maximum operating temperatures, and hot/warm gas cleanup.

- Emissions control testing:
  - Mercury control at high temperatures
  - Particulate control
  - NOx control from combustion turbines
  - Fate of trace elements

- Determine the chemical and physical characteristics of byproducts such as ash, slag, sulfur, and particulates from the gas cleanup and identify uses for the byproducts.
- Evaluate process gases for compatibility with CO_2 sequestration technologies.
- Conduct a detailed comparison of Texas lignites with other coals, focusing on the opportunities for Texas lignites.

4. SUMMARY OF CLEAN COAL RESEARCH ACTIVITY

There are currently 33 clean coal research and development projects under way in Texas with a total value of at least $33.77 million, according to the U.S. Department of Energy, with funding shared by DOE and the private sector. Project participants include DOE, universities, research centers and private industry.

One example of this cutting-edge, collaborative research is the Bureau of Economic Geology (BEG), a major research unit of the University of Texas at Austin, which is now in the second phase of a DOE-sponsored study of carbon dioxide sequestration. The $3.25 million Frio Brine project is a pilot-scale field experiment near Houston to determine the best saline aquifer candidates for long-term CO_2 sequestration.

Through BEG, Texas is an undisputed leader in CO_2 sequestration research and the state should support those efforts and work in partnership with BEG on coal gasification technology, but only if CO_2 sequestration is shown to be feasible.

The primary method of reducing CO_2 in the atmosphere is through carbon sequestration. The Frio Brine project included injecting and monitoring 1,600 tons of CO_2 into a mile-deep brine formation well 30 miles northeast of Houston. The test is providing unique data to help investigators understand the viability of geologic sequestration as a means of reducing greenhouse gas emissions.

Enhanced oil recovery (EOR) offers an additional use for CO_2 in the Permian Basin, in East Texas and along the Gulf Coast. Since 1985, EOR has grown and now accounts for just over 15 percent of Texas' average yearly petroleum production. The Bureau of Economic Geology at the University of Texas at Austin estimates that 31 billion barrels of oil in Texas are recoverable using carbon dioxide-driven EOR.

TXU is representative of private sector involvement in clean coal research, teaming with the Energy and Environmental Research Center, the Lignite Energy Council, the Electric Power Research Institute and URS Corp. in large scale mercury control projects totaling $2.9 million at two of its power generation sites.

Eastman Chemical Company, which has a major manufacturing site at Longview, Texas, demonstrated a new DOE-sponsored liquid-phase methanol process using coal-based syngas, is participating in a major DOE project with Research Triangle Institute to develop hot syngas cleanup systems, and is evaluating participation in a number of other gasification-related DOE-sponsored research programs.

Other examples of involvement by Texas companies, including Westmoreland Coal Company and North American Coal Corporation, in participation and planning of coal research projects are:

- Pilot and full-scale demonstration of advanced mercury control technologies for coal- and lignite-fired power generating plants.

- Planned tests to determine lignite's performance characteristics as a fuel in an IGCC system, and research to improve mercury capture and to develop activated carbon for mercury control.

Texas should accelerate its research and development efforts in the area of coal gasification if the advantages of this emerging technology are to be fully realized. The EERC is a recognized research leader in the field. DOE grants received by Texas institutions, however, demonstrate their capability to assume a more prominent role and the state should encourage investments for them to move more aggressively into this area.

{A detailed listing of ongoing Texas research projects is included in Section II, Chapter 3 of this report.}

RECOMMENDATIONS

Texas is not currently in a position to reliably estimate the time it will take to secure the permits necessary to construct clean coal technology projects leading to and including the key component of FutureGen. This lack of predictability is the result of the lengthy (often 3-5 year) process for contested case hearings on the air, water, waste and mine permits that will be necessary to facilitate clean coal technology projects and FutureGen.

- Legislative – Passage of the proposed legislation will establish the framework to advance clean coal technology in Texas and enhance the state's bid for FutureGen.

- Regulatory – Streamline the permitting mechanisms to the maximum extent allowed by federal law in order to significantly shorten and make more predictable the permitting timeline for clean coal projects, including key components of FutureGen. None of these proposals loosen state or federal environmental protections or restrict public participation.

- Research and Development – Texas must maintain leadership in CO_2 sequestration by working with the University of Texas' Bureau of Economic Geology and aggressively advance its coal gasification research in partnership with the University of North Dakota's Energy and Environmental Research Center.

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Section II: Clean Coal in Detail

1. Texas Coal:
Usage and Challenges

TEXAS COAL: USAGE AND CHALLENGES

Nationwide, coal is the most abundant U.S. energy resource, with domestic reserves exceeding the energy potential of the world's oil reserves. Texas has a substantial supply of lignite that has allowed Texans to enjoy relatively low electric rates, but various factors have encouraged power generators to switch to other imported coal sources or to build plants fueled by natural gas or other fuels. Further fuel-switching should be discouraged in order to avoid adverse impacts that could affect the State's economy, jobs, and electricity rates.

Coal mining and coal-fueled electric generation in Texas account for over 33,000 direct jobs and almost $10.5 billion annually in total expenditures. (Fig. 1) In addition, this economic activity is responsible for more than $300 million in annual state and local revenue.[1] In many counties, taxes from mining and power generation contribute over half of the funds for county services as well as school district operations. The majority of Texas' coal mines are located in East Texas, where coal mining supports about 7210 jobs, $154 million in annual retail sales and $1.4 billion in total expenditures.[2] Workers at the mines earn an average annual salary approximately 114% of the statewide average for all occupations.

On the production side, Texas has been the largest consumer of coal in the United States since 1981 and is also the 5th largest coal producing state in the nation. In 2002, Texas accounted for about 9% or 99.32 million tons of total domestic consumption. (Sources: NMA, DOE EIA) (Fig. 2) Almost all (99.9%) of the 48.18 million tons of lignite mined in Texas is used to generate electricity for the Texas market. The balance of Texas coal consumption, which is about 55% or 51.14 million tons, is imported, primarily from Wyoming. Between 1989 and 2002, the share of Texas lignite supplying the Texas market declined from 59 percent to 45 percent while coal from Wyoming, Colorado and Utah increased from 41 percent to 55 percent.

Texas is estimated to have coal resources in excess of 9.67 billion tons or about 3% of total U.S. reserves. The state has 21 permitted surface mines of which 13 are operating and producing coal, 2 are under construction, and 6 are no longer producing but are being reclaimed. (Source: Railroad Commission of Texas) At current production rates, the Texas reserves represent 200 years of supply. (Energy Information Administration)

Coal reserves in Texas are primarily Gulf Coast lignite. (Fig. 3) The relatively low calorific value (Btu) and high ash and moisture content of lignite make it best-suited and most economical for consumption in mine-mouth electric generation plants. Despite the significant reserves of coal in Texas, production of lignite generally has declined in Texas since the early 1990's and been replaced by increasing amounts of coal imports. (Source: Railroad Commission of Texas) (Fig. 4) Reasons for this trend include stringent emissions regulations and permitting constraints that make it easier for electric generators to switch to other coals instead of going through the permitting process to install improved emissions technologies.

[1] Perryman Group 2004
[2] Perryman Group 2004

Use in Electricity Generation

About 90 percent of all coal produced in the U.S. is used for electricity generation, and over half of our Nation's electricity is produced by coal-fired power plants. Meeting our Nation's rising demands for clean and affordable electricity will require the use of coal for the foreseeable future. Therefore, technologies must be developed and demonstrated to enable the continued use of coal and lignite to meet our growing demand for electricity in an environmentally sound manner.

Texas is the largest generator of electricity in the nation, but for several reasons use of coal for electric generation in Texas has declined since 1994 from over 50 percent of the total to 37 percent. Texas lignite generates 19 percent of the state's electricity, with most of the balance of power from coal being made up by Powder River Basin (PRB) subbituminous coal, imported from Wyoming, which supplies an increasing amount of the coal used in Texas. Texas has 36 coal-based electric generation units that are capable of producing a combined total of over 17,900 MW. These units supply base load electricity because coal is relatively inexpensive and because of the length of time it takes to bring a coal-based unit on-line or take it off-line to address fluctuations in electricity demand.

Since 1992, no new coal fired capacity has been brought on line in Texas as compared with nearly 32,000 MW of new gas-fired capacity. This incongruity occurred in part due to recent emission reduction mandates and permitting difficulties for coal-fueled plants. As demand for electricity in Texas has grown, natural gas-fired generation was favored because it can be brought on line more quickly due to a less burdensome permitting process; it typically emits fewer pollutants; and construction is less capital intensive. Further, SB 7, passed in 2001, and its resulting rule changes favored other fuels with a mandate that 50% of new generation be natural gas-fired and the creation of a renewable portfolio standard. The result of these factors has been that Texans have been hit with higher electric bills as natural gas prices continue to rise.

This comes at a time when emissions from coal-fueled generation have been significantly reduced as evidenced by Texas electric generators' nitrogen oxides (NO_x) and sulfur dioxide (SO_2) emission rates, which are currently 50 percent below the national average. Further SO_2 reductions from electric generating facilities mandated by the Federal Clean Air Act have resulted in increased use of lower sulfur fuels, namely PRB subbituminous coal. This shift away from lignite may be countered by the emergence of gasification, which offers the ability to capture most pollutants prior to combustion. As gasification technologies become more affordable, an even sharper reduction in emissions will be observed. To the State's benefit, lignite is an acceptable fuel for gasification, with certain benefits due to its relatively high reactivity and conversion.

The low and stable cost of coal and lignite makes coal-fueled plants less expensive to run from a fuel source standpoint, especially with today's natural gas markets. (Fig. 5) Natural gas prices increased 83% between 2000 and 2003 while coal prices were comparatively stable.[3] In 2003, the relative cost of coal to generate electricity was about $1.28 per million

[3] As Above.

Btu compared to natural gas which cost $5.60, petroleum which cost $4.61 and nuclear which cost $1.80[4].

With respect to coal gasification, which holds significant promise for the future, the cost of electricity (COE) is currently near parity with that of conventional coal combustion technologies when one includes environmental, water supply, and waste disposal costs. While capital costs for IGCC may be 10-15% higher than that of conventional coal-fired plants, production costs (including emissions costs and allowances) are comparably lower. Considering the typical range of fuel and other costs, the cost of electricity of IGCC may currently be expected to range from $43 to $47/MWh, which is similar to COE from conventional coal combustion technologies. If gasification were used to refuel an existing natural gas-fired power plant where the combined cycle power plant investment has already been spent, the cost of electricity from such an IGCC could be reduced to a range of $35 to $43/MWh. For comparison, the COE for a natural gas-fired combined cycle plant at $6.00/MMBtu natural gas is estimated to be over $60/MWh at current capacity factors of less than 50% for such facilities (according to Bill Rosenberg of Harvard University's Kennedy School of Government).

Anticipated Electricity Demand

Historically, Texas has experienced high rates of population growth. The population in Texas grew by 22.8 percent between 1990 and 2000, and while the rate of growth slowed after that year, the state population reached 22,118,509 in 2003, an increase of 1,266,689 in three years, according to census data. The state demographer expects that Texas' historical pattern of rapid growth will continue. Projections indicate that by 2010, the population in Texas will grow to between 25.4 million and 26.1 million, an increase of 4.6 to 5.2 million. The number of people living in Texas is expected to double between 2000 and 2040, with projections for a total population ranging between 35.7 million and 51.7 million.

As the population increases, so too will demand for electricity. Demand in Texas grew over 34% between 1990 and 2003 and is expected to grow another 34%, or about 30,000 MW by 2015.

If electricity demand increases and coal retains its share of 37 percent, then the amount of coal required will also grow. If this demand were satisfied by Texas coal, the number of tons used as fuel in electric generating plants annually would increase to over 60 million tons by 2015. These increases would also lead to significant increases in both direct and indirect jobs and, with that, significant new local and state revenues.

Challenges to Coal Use

There are a number of considerations that prevent a quick and substantial increase in coal use for electric power generation. The restrictive and complicated federal environmental policies of the past several years have combined to create an uncertain regulatory environment and

[4] National Mining Association; National Coal Council; DOE Energy Information Administration and EIA.

discouraged the construction of new power plants that would use relatively inexpensive and plentiful coal. These policies have promoted more use of other fuels, some of which are subject to drastic price fluctuations and long-term supply uncertainty.

The nature of proposed national air emission reductions currently under consideration and existing permitting processes pose an enormous challenge to the viability of the Texas coal and lignite industries, so clean coal technologies and coal gasification must be encouraged. Otherwise, further proposed emissions reductions may provide power generators continued, significant incentives to switch to other fuels. Once this occurs, the long lead time and large capital expenditures required to open mines and build coal-based power plants will make it extremely difficult for the industry to be revived and the trend reversed. Texas will lose jobs, income and tax revenues. Texas must encourage and promote its fuel diversity and energy independence.

In addition to challenges in the regulatory arena, coal also faces challenges in infrastructure, tax structure, public sentiment and workforce development.

Regulatory

1. New Source Review

New source review (NSR) is a complex permitting program created by the Federal Clean Air Act which requires electric generators to undergo pre-construction review. The NSR program was designed to be triggered when a new facility is being built or when an existing facility is undergoing a major modification that could significantly increase emissions.

For the most part, routine maintenance, repair and replacement activities historically have been exempt from NSR. For years the EPA understood that parts must be replaced due to regular wear and tear or breakage and that such activities met the routine maintenance, repair and replacement exemption. During the previous administration, EPA changed its interpretation to require plants making routine repairs to install additional, expensive pollution control technologies.

Responding to a bipartisan call for reform, in October 2003, EPA announced changes in the way the program works for existing facilities. These improvements do not change the NSR program as it applies to new facilities and do not change which facilities are subject to the NSR rules.

The change established an annual routine replacement allowance of 20% of the replacement value, so that activities undertaken to promote the safe, reliable and efficient operation of a plant whose costs fall within the allowance would automatically constitute routine maintenance. Such changes to a facility must not increase the hourly potential for emissions.

Additional changes are needed to encourage the installation of clean coal technologies so consumers can have the double benefit of enjoying electricity at reasonable prices and having improved air quality at the same time.

2. Water and Other Substances

The increasingly complex regulatory framework regarding the impact of coal-based power plants on water quantity and quality discourages the development of new plants. In particular, the large quantities of make-up water required for traditional coal-based plants necessitates construction of a lake or numerous high-producing wells which must be permitted by the Corps of Engineers (COE) and TCEQ. In addition, approval has become more and more problematic because of objections by down-stream water rights holders and environmental groups concerned about rapid growth in population and water demand in the state, indicating a need for increased public outreach by the private companies as they go through the permitting process. One of the advantages of coal gasification technology is that it uses approximately 40% less water than coal combustion technologies, which diminishes the negative impact of such approvals.

3. Permitting Processes

Federal and state permitting processes for new coal-based electric power generation units and mines are complex, lengthy, expensive and at times unpredictable. They discourage investments in needed new capacity and mines that not only fuel new power plants, but also provide much needed economic stimulus to rural communities. At the same time, ease of permitting and lower capital costs have led to rapid growth in gas-fired generation. Regulatory review and authorization by the EPA, TCEQ and the Railroad Commission of Texas (RRC) is necessary, but a new process for permitting clean coal technologies should be developed. In particular, the permitting processes for the most advanced and cleanest coal technologies, such as gasification, should be streamlined to encourage their adoption.

4. Power plant timeframes and costs

The biggest impediment to construction of a new generation facility is the time and expense to site, permit and construct the facility. Since competition has been delayed in the non-ERCOT areas of Texas, the utilities in these areas remain bundled for the time, allowing for the recovery of the costs of new plants and improvements through rate adjustments; however, that status could change to a competitive environment before the completion of new generation in this area which would make it difficult to recover costs. The theory behind the deregulated environment is that utilities will offer the lowest prices possible in order to lure more customers. Unfortunately, capital expenses are difficult to recover in this environment resulting in a lack of motivation to build or improve facilities.

Transportation and Other Infrastructure

1. Rail Capacity

Rail transportation of subbituminous (western) coal and to a lesser extent lignite, is essential for efficient and cost-effective delivery of solid fossil fuels to electric generation plants in Texas. The alternatives to railroads are trucking, barging and pipeline slurry. Trucks cannot deliver more than sixty tons per load compared with more than 15,000 tons for a western coal train. Trucking costs approximately 100 times more than rail transportation for long distances. Trucking does have its niche when very small shipments are required, the shipping distance is less than fifty miles, or rail transportation is not an available option. Barging is not a viable alternative in Texas due to the limited number of navigable waterways, and coal slurry pipelines are not commercially practical at this time.

2. Transmission

Currently the lack of a free market for electricity throughout the US hampers Texas from trading and exporting electricity beyond its borders. Consequently, any large net surplus of electricity that Texas could generate in the future could not be exported. Over the long term, Texas should strive to become a net exporter of electricity - from existing interstate systems within our state - and clean coal technologies because of its advanced deployment of state-of-the-art clean coal technologies and abundant natural resources.

Tax Structure and Royalties

The Texas lignite industry presently pays more than $85 million annually in state, county and local taxes and landowner royalties.

Recently, proposals have been put forward at the state level to levy various taxes on electric generating plants. These proposals, such as a severance tax on coal or a tax on emissions from electric generation plants in the state, would hurt the Texas economy and its citizens by raising electric rates while providing little improvement to the environment.

Any new tax or fee on legally permitted air emissions will increase business costs for operating companies and weaken the State's competitiveness compared to other states and countries. Many East Texas communities and school districts rely on lignite mines and electric generation plants for their main tax base. Some school districts rely on these facilities for over 50% of their tax revenue.[5]

Public Sentiment

While coal-based electric generation practices have changed and emissions have dropped dramatically over the past 30 years, the public remains largely uneducated about the improvements. Similarly, they have little understanding of the relative inexpensiveness of coal compared to other energy sources, especially renewables. Campaigns in other states have improved the public's knowledge and increased the public's support of existing and new coal-based generation. A campaign in advance of new mining projects and coal-fueled electric generation will be necessary to address the lack of current knowledge and to counter erroneous information.

Workforce Development

Like many industries, the mining and transportation workforce is aging and the industry faces losing highly trained and experienced workers as they retire over the next 5-10 years. The industry must work with appropriate institutions to recruit and prepare replacements. This presents an opportunity, particularly for rural communities, to become part of an effort to train young people to step into these jobs (i.e. well paid, stable jobs with benefits for young people). This effort will take a coalition of industry, higher education and K-12 institutions and economic development agencies.

[5] TMRA

2. Strategies for Coal Use

STRATEGIES FOR COAL USE

The plentiful supply and relatively low and stable price of coal make it a natural fuel source to meet the anticipated increase in electricity demand as the population grows in Texas. As in-state oil and gas reserves are depleted, coal and lignite should play an increasingly important role in helping Texas maintain its supremacy as the premier supplier and net exporter of energy in the nation. Taking steps to promote and assure the continued use of coal will free up remaining reserves of natural gas for more efficient utilization, such as production of chemicals. Additionally, it can contribute to the nation's goal to reduce its dependence on foreign energy sources and therefore improve homeland security.

It currently takes about five to eight years to get a new advanced clean coal plant such as gasification sited, permitted, financed, and constructed. With a high proportion of the existing fleet of power plants and lignite mines nearing the end of their projected lifespan, planning for replacement facilities must begin now. Increasing demand for electricity as the state's population and industrial base expand will necessitate the expansion of the state's power generation and transmission capacity. Continuing the use of coal will maintain the supply of affordable reliable electricity, reduce pressure on natural gas markets and generate jobs and revenues benefiting Texas. The development of clean coal technologies will enhance the existing attractiveness of coal with the additional benefits of maintaining and enhancing the high level of environmental quality currently enjoyed.

The challenge facing the industry and state leaders is to grow the industry, while new combustion and emission technologies, particularly gasification, are brought to the market. In the meantime, many mines and power plants are nearing retirement. Plans for replacement plants must include the expanded use of coal and lignite in order to maintain affordable electricity. This section outlines a vision for Texas, which indicates an expanded role for coal and lignite in providing dependable, affordable electricity and other fuels to residents and businesses. To reach these goals, a supportive legislative and regulatory environment must be encouraged and public opinion must be conducive first to maintaining and then to further developing the industry.

Goals

1) Develop and Deploy Clean Coal Technologies

Texas will become a center for the research and deployment of clean coal technologies, including coal gasification and other innovative approaches. To achieve this status, the CCTC will encourage research, development and deployment of clean coal technologies in new and existing power plants. It will take the lead on developing public support and understanding of the continued use of coal. Texas will collaborate with other coal and lignite producing states to promote the development and use of clean coal technologies.

The deployment of these technologies will allow the power generation industry to install new clean coal utilization and emission control technologies at their facilities that will use coal more efficiently. Planning for replacement plants will incorporate new technologies and processes.

2) Site and Develop FutureGen in Texas

Led by the CCTC's efforts, Texas will be selected as the site for the DOE FutureGen project. New technologies resulting from the FutureGen project will allow upgraded and replacement plants to begin producing new fuels and feedstocks for industrial and transportation uses, in addition to reliable and reasonably priced electricity with low emissions. Components of coal recovered from the gasification process and gasification-based syngas itself will be utilized as building blocks by the chemical industry. Pilot projects will take carbon dioxide from these plants to be "sequestered", partially through utilization in areas with oil and gas reserves to increase or prolong production from these fields.

Within fifty years, the fleet of existing coal-combustion power plants will be completely retired and replaced by new plants fueled by coal and utilizing technologies that produce near-zero emissions. These plants also produce innovative new fuels that are equally clean burning and can play an important role in America's energy independence.

3) Expand the Coal and Lignite Industry

To maintain affordable electricity and meet increased demand, which is projected to occur over the next ten years, the use of coal will have to expand. Coal will continue to fuel at least 37% of electric generation in Texas, even as demand for electricity increases, meaning that the coal industry will have to expand. The increased demand will be met with the permitting of new mines, expansion of existing mines and construction of new generation facilities.

The priority for Texas is to further develop its in-state coal reserves, while also recognizing the benefits of low-cost, low-sulfur western coal, to supply this increase in electricity demand. This will maintain diversity of energy supply, maintain electric reliability, provide supply and pricing stability for electricity consumers, and reduce America's dependence on foreign energy and thus, increase homeland security.

Communities will benefit from the economic impact of an expanded mining industry. Mining lignite and coal supports highly paid, permanent jobs and generates state and local taxes that are vital to rural communities and provide funding for public schools. Rural communities in Texas, as well as the state government, will benefit from the jobs, income and revenues produced from the coal-fueled plants, mines, and associated facilities. In addition to jobs created in the mining and power generation industries, deployment of gasification technology can lead to significant numbers of new jobs in the chemical, fertilizer, hydrogen, and transportation fuels industries that also utilize the syngas produced by gasification.

At the state level, Texas will ensure it creates and maintains the regulatory, fiscal and physical infrastructure to support the use of coal necessary to supply Texas's growing demand for electricity. Environmental regulations governing the energy industry will be

based upon sound science and risk analysis and will be applied equitably to all forms of energy development in the state. The Texas government will ensure that all sources of air and other pollution continue to be regulated in an equitable manner according to their individual contribution and that electric generating units do not bear regulation and/or costs in excess of their improvements to public health or the environment. Texas will be a national model for efficient regulatory oversight and cost-effective environmental regulation of the energy industry. Texas will continue to meet or exceed all federal environmental standards.

Texas will work with the federal government to ensure federal legislation and rulemaking does not negatively affect the development and use of coal.

4) Further Develop Rail and Transmission Infrastructure

The rail transportation and coal-based power generation industry will expand to meet the increased demand stemming from economic and population growth for reliable and reasonably priced electricity generated from coal. This expansion will require the permitting of expanded rail service. The capacity of the transmission system to serve new residents and businesses in Texas will have been increased by new technologies and expansion of the physical network. Because of these advances in technology, the Texas power generation industry will also be able to produce low-cost, clean electric power to support the Texas economy.

Effects of Goals

As the above goals are met, several positive effects will be realized.

1) Industry will be attracted to advances and products of Clean Coal Technology

Texas' clean coal research facilities and its coal resources will be promoted to support the attraction and construction of new industrial facilities. The industrial and transportation sectors will benefit from the innovative fuels and feedstocks produced from gasification facilities and the FutureGen project.

2) Texas will become an exporter of Clean Coal Technology

Texas will become a global exporter of clean coal technologies developed through FutureGen and the research and development activities of Texas' universities and companies. Texas will capture a significant share of the global market, which is projected to be $500 billion.

3) Texas will become a National Model for Energy Partnerships

Texas will be a national model for partnerships between lignite, coal, other fossil fuels and renewable energy, providing dependable and reasonably priced electricity with a minimum level of environmental impact. Use of renewables along with energy from clean coal technologies will free natural gas supplies for other uses.

4) Electricity will be exported

Texas will become a net exporter of electricity, from existing interstate systems within our state, primarily because of its deployment of state of the art clean coal technologies and development of its affordable lignite reserves.

3. Clean Coal Technology Research in Texas

CLEAN COAL TECHNOLOGY RESEARCH IN TEXAS

Current Clean Coal Technologies can be applied at the pre-combustion, combustion and post-combustion stages of the utilization of coal. Additionally, gasification offers tremendous promise as the technologies become more affordable.

Gasification technologies represent the next generation of solid-feedstock-based energy production systems. Gasification breaks down virtually any carbon-based feedstock into its basic constituents. This enables the separation of pollutants and greenhouse gases to produce clean gas for efficient electricity generation and production of chemicals and clean liquid fuels. They provide flexibility in the production of a wide range of products including electricity, fuels, chemicals, hydrogen, and steam. And perhaps most important, in a time of electricity- and fuel-price spikes, flexible gasification systems provide for operation on low-cost, widely-available feedstocks.

Gasification-based plants can meet all projected environmental regulations, solving the compliance problems of both electric power generators and liquid fuel producers. The water required to run an IGCC plant is less than half that required to run a pulverized coal plant with a flue gas scrubbing system. Because they operate at higher efficiency levels than conventional fossil-fueled power plants, gasification systems emit less CO_2 per unit of energy. If there is a requirement for reduction of CO_2, gasification-based coal-fueled plants offer the most economic technologies as compared with other coal-based technologies or natural gas combined cycle plants. The sale of by-products from the gasification process minimizes waste disposal and further improves the environmental and economic outlooks of gasification-based plants. In fact, the 2001 National Energy Policy maintains "one of the most promising new approaches to using coal for clean production of electricity is integrated gasification combined cycle (IGCC)."

In a time of electricity and fuel-price spikes, flexible gasification systems provide for operation on low-cost, widely available feedstocks. The recent National Research Council study, Vision 21 – Fossil Fuel Options for the Future, cites gasification as the focus of the Office of Fossil Energy's Vision 21 Program: *"The committee believes that the focus of the enabling technology programs (and of the Vision 21 Program) should be coal gasification…"*

The DOE Gasification Program has a history of success in technology development and demonstration. The R&D portfolio of today's program will enable deployment of the clean and affordable energy systems required for growing energy markets.

Other Clean Coal Technologies currently in use include:

Beneficiation

Coal beneficiation, also known as coal preparation, is the cleaning process in which mineral matter is removed from mined coal in order to produce clean coal. The main function of this process is to increase the heating value and the quality of the coal which is achieved by

lowering the level of sulphur and mineral constituents.

Biomass Cofiring
For utilities and power generating companies with coal-fired capacity, cofiring with biomass may represent one of the least-cost renewable energy options. Cofiring involves replacing a portion of the coal with biomass at an existing power plant boiler.

Capture and Sequestration of Carbon Dioxide
Carbon capture and sequestration (CC&S) technologies provide a means of delivering deep reductions in CO_2 emissions.

Coal-fired Gas Turbines
Gas turbines are used in many plant types, such as simple cycle, combined cycle and combined heat and power, as well as in hybrid advanced power cycle systems.

Cogeneration
Generating both electricity and useful heat from the same power plant is called combined heat and power (CHP) in Europe and cogeneration in North America. Most CHP systems are designed to simultaneously produce electric power (to be used on site or sold back to an investor-owned utility or both) and thermal heat for industrial processes or the heating and cooling of buildings.

Combined Heat and Power
Generating both electricity and useful heat from the same power plant is called combined heat and power (CHP) in Europe and cogeneration in North America. Most CHP systems are designed to simultaneously produce electric power (to be used on site or sold back to an investor-owned utility or both) and thermal heat for industrial processes or the heating and cooling of buildings.

Combustion - Pressurized Pulverized Fuel
Pressurised pulverised combustion of coal (PPC) is similar to conventional pulverised fuel combustion, in that it is based on the combustion of a finely ground cloud of coal particles, but it occurs in a pressurised environment, enabling operation in combined cycle.

Combustion - Pulverized Fuel
Pulverized fuel combustion (PCC) involves grinding coal into fine particles and injecting it, with air, into the lower part of a combustion chamber. The particles burn in suspension and release heat.

Combustion Modifications for NOx Control
Combustion modification techniques prevent the formation of NOx during combustion or destroy the NOx formed during primary combustion.

Electrostatic Precipitators
Electrostatic precipitators (ESPs) are on of the main technologies available to control particulate emissions (eg dust) from coal-fired power plants.

Fabric Filters
Fabric filters, also known as baghouses, collect particulates from flue gas on a tightly woven fabric by sieving and other mechanisms.

Flue Gas Desulfurization
The post-combustion sulphur control is called Flue Gas Desulfurization (FGD).

Flue Gas Treatment for NOx Control
Combustion modification techniques prevent the formation of NOx during combustion or destroy the NOx formed during primary combustion.

Fluidized Bed Coal Combustion
Fluidized bed combustion (FBC) has emerged as an environmentally attractive method for burning coal because of low NOx emissions and an ability to capture sulfur pollutants inside the bed.

Fuel Cells
(using Hydrogen from Coal)
A fuel cell is electrochemical device which directly converts the chemical energy stored in a fuel into electrical energy.

Hot Gas Clean Up
Hot gas cleanup technologies have emerged as key components of advanced power generation technologies such as pressurised fluidised-bed combustion and integrated gasification combined cycle to protect the downstream heat exchanger and gas turbine components from fouling and erosion to meet emission requirements.

Integrated Gasification Combined Cycle (IGCC)
IGCC is emerging today as one of the most promising technologies to exploit low-quality solid and liquid fuels and meet the most stringent emission limits.

Low Sulfur Coal
According to the USGS Coal Resource Classification System, low-sulfur coal contains 1% or less total sulfur, on an as-received basis. Sources of low sulfur coal include the USA's Powder River Basin, western Canada, Indonesia, Australia and South Africa.

Nitrogen Oxides (NOx) Control
Combustion modification techniques prevent the formation of NOx during combustion or destroy the NOx formed during primary combustion.

Pollution Control Equipment
Combustion modification techniques prevent the formation of NOx during combustion or destroy the NOx formed during primary combustion.

Supercritical Power Plants
Supercritical is a thermodynamic expression describing the state of a substance where there is no clear distinction between the liquid and the gaseous phase (that is, they are a

homogenous fluid).

Thermal Efficiency
Thermal efficiency is a measure of the ability of the heat exchanger to transfer heat from the combustion process to the water or steam in the boiler.

Ultra-Supercritical Power Plants
Supercritical is a thermodynamic expression describing the state of a substance where there is no clear distinction between the liquid and the gaseous phase (that is, they are a homogenous fluid).

Waste Cofiring
For utilities and power generating companies with coal-fired capacity, cofiring with biomass may represent one of the least-cost renewable energy options. Cofiring involves replacing a portion of the coal with biomass at an existing power plant boiler.

Clean Coal Technology: The Need for Continued Progress

The Bush Administration is advancing its new vision in clean coal research. The Clean Coal Power Initiative (CCPI) is an effort within the Department of Energy's Fossil Energy program that combines industry investments in research and development with federal matching funds for research, development and demonstration of advanced technologies on coal-fired power plants.
As part of this Presidential Initiative, including FutureGen, the administration is requesting a total of $447 million ($210 million for core budget + $237 million for FutureGen) in FY 2005 to promote joint government-industry-funded research projects on new technologies that can enhance the reliability, efficiency, and environmental performance of coal-fired power generators. These projects will decrease dependence on imported fuels, provide emissions reductions for cleaner air, and offer the economic benefits of utilizing a native fuel.

The announced 10-year, $1 billion public-private FutureGen project to develop the world's first coal-based nearly emission-free power plant is a major part of this effort. The Integrated Sequestration and Hydrogen Research Initiative (FutureGen) announced by the President in 2003 envisions a global effort to build the world's first near-zero emission power plant. The power plant would be an international test facility for new technologies by pioneering advanced hydrogen production from coal, capturing and permanently sequestering carbon dioxide, and utilizing carbon dioxide for enhanced oil recovery. Texas should pursue opportunities to be the center for this research and development effort, maintaining and enhancing its position as the world leader in energy development, efficiency and conservation. FutureGen is discussed in greater detail in a separate chapter of this report.

The coal industry in partnership with universities, the Department of Energy and the EPA is engaged in research to develop more efficient combustion technologies that will reduce emissions and improve efficiencies of existing plants. Similarly, in response to public

demand, the industry is researching new technologies to improve the capture of emissions for the various types of coal and combustion systems currently employed.

Research using technologies that involve gasification of coal appear to be the most promising. This methodology will meet stringent environmental regulations, will utilize a domestic fuel resource, and will greatly expand the uses of coal and lignite in the energy system. Commonly referred to as Integrated Gasification Combined Cycle (IGCC) technologies when used for electric power generation, not only do they significantly reduce emissions to near zero levels, in particular by making it significantly easier to capture carbon dioxide and volatile mercury, these technologies use coal more efficiently. Research is underway on such technologies that specifically utilize lignite or combinations of lignite and other carbon-rich fuels.

In addition to the advantages these technologies create by producing electricity more efficiently and cleanly, they are also being evaluated for their potential to produce hydrogen, which may replace oil as a primary fuel for vehicles. This possibility forms the basis for the concept of FutureGen and, once proven feasible, will guarantee a substantial future role for coal in providing the nation's energy.

Accomplishments and Challenges

Over the past 35 years, the public has sought reductions in emissions from power plants, the first step being the enactment of the Clean Air Act in 1970. Power plant emissions under the most scrutiny are SO_2, NO_x, CO_2, fine particulates and mercury. Dramatic improvements in air quality have occurred even with significant increases in energy consumption from business, industrial and population growth. (fig. 6)

> "Since 1970, aggregate emissions of the six principal pollutants have been cut 48 percent. During that same time, U.S. gross domestic product increased 164 percent, energy consumption increased 42 percent, and vehicle miles traveled increased 155 percent."[6]

SO_2 emissions decreased approximately 33 percent from 1983 to 2002. Nationally, average SO_2 ambient concentrations have been cut approximately 54 percent over the same period.

The two primary man-made sources of NO_x emissions are transportation and stationary source fuel combustion contributing 56 and 37 percent, respectively, of 2002 total NO_x emissions. NO_x emissions from power generation units in 2001 were 5 percent lower than they were in 2000.[7]

Simultaneously with national reductions, Texas has been diligent in its efforts to reduce power plant emissions. Electric generators in Texas have NO_x and SO_2 emission rates that are currently 50% below the national average. Of the 36 coal units in Texas, 15 are scrubbed, which is more scrubbed capacity than any other state.

[6] US EPA 2003 National Air Quality and Emissions Trends Report
[7] U.S. EPA, 2003 National Air Quality and Emissions Trends Report, see http://www.epa.gov/oar/aqtrnd03/

The Texas Commission on Environmental Quality (TCEQ) recently implemented new limits for NO_x emissions from power plants, resulting in Texas electric generators installing over $1 billion in additional control equipment between 2000 and May 2005.

In addition, EPA is proposing two further SO_2 and NO_x emission reductions and is reviewing a regulation to reduce mercury emissions from coal-fueled plants. These new rules are being finalized without the benefit of understanding the effect of current rules that are still in the process of being implemented. Given the significant accomplishments already achieved by power generators, additional reductions will be very costly and may stretch the limits of technology.

The scientific justification for the proposed mercury rule has been questioned and is under review. Lignite will be especially challenged since no technology has yet been demonstrated to achieve the proposed level of mercury emissions from lignite-fired plants. Gasification offers great hope and has demonstrated significant achievements in mercury removal for other coal types, but the technology has not yet been commercially demonstrated for lignites.

The specter of a difficult, if not impossible to meet, mercury emission limit plus the added cost of either installing additional SO_2 and NO_x control equipment or purchasing SO_2 and NO_x emission allowances at greatly increased prices is causing power plant operators to seriously consider their long-term fuel options, which include switching to other forms of coal or switching fuels entirely.

Despite the achievements made in emissions reductions, power generators have found that the cost of emissions controls has made it more effective to import Western coal for its lower emissions potential. Although Texas has in excess of 9.6 billion tons of lignite reserves which represents 200 years of supply at current use, two lignite mines have closed in the last five years, and no new lignite-fired plants are under construction in the state.

The reduction of Greenhouse Gases (GhG), which have been argued to affect climate change, is another important benefit of Clean Coal Technology and FutureGen. The electric utilities in Texas have historically taken an active role in the voluntary reduction of carbon dioxide (CO_2). Since the signing of the Rio Treaty by the first Bush Administration in 1992 and implementation of voluntary reporting in 1994, the number of entities reporting reductions has grown by 111%, with the number of GhG reduction projects growing by 220%. The most recent report (2002) shows that voluntary reductions led by electric utilities equate to a 15% offset of our nation's GhG production. Closer to home the electric utilities with operations in Texas (AEP-Tx, City of Austin, CPS-San Antonio, Entergy, LCRA, Texas Genco, TXU, Xcel) initiated 226 voluntary GhG reduction projects in 2002. These projects resulted in reductions of over 49,000,000 metric tons of CO_2.

The primary method of reducing CO_2 is through a process called carbon sequestration, which is a process of storing carbon geologically in appropriate formations or ecologically in plant communities. The University of Texas' Bureau of Economic Geology has been partnering with the U.S. Dept. of Energy to test the viability of sequestering carbon in brine formations

along the gulf coast. The field test included injecting and monitoring 1,600 tons of CO_2 into a mile-deep well 30 miles northeast of Houston. The test is providing unique data to help investigators understand the viability of geologic sequestration as a means of reducing greenhouse gas emissions.

Enhanced oil recovery (EOR) offers an additional use for CO_2 in the Permian Basin, in East Texas and along the Gulf Coast. Since 1985, EOR has grown and now accounts for just over 15 percent of Texas' average yearly petroleum production. The Bureau of Economic Geology at the University of Texas at Austin estimates that 31 billion barrels of oil in Texas is recoverable using carbon dioxide-driven EOR.

The direct economic benefits to Texas of recovering 31 billion barrels of oil from fields are staggering. Based on $25 oil, the economic value of recovering just half of that (15.5 billion barrels) would be a wellhead value of $338 billion; severance tax, $18 billion; ad valorem tax, $15 billion; jobs created, 7.4 million; economic value, $1.1 billion; franchise tax, $2 billion; and sales tax, $23 billion.

Specter of Increased Regulation of Coal Combustion Products (CCPs)

CCPs are generated during the burning of coal in electric generating plants. CCPs are often reused and recycled, resulting in environmental, energy, and economic benefits. Based on multiple studies conducted by EPA over at least the past 20 years, EPA has consistently determined that CCPs do not warrant hazardous waste regulation. Nonetheless, environmental groups continue to take the position that EPA should require increased regulation of CCPs.

In fact, gasification and FutureGen will provide the ability to harvest various components of the coal for use by the chemical industry.

Research and Development/ Clean Coal Technology

As a result of the last Texas Legislative Session, the Governor created the Clean Coal Technology Council of Texas, headed by Railroad Commissioner Michael Williams, to investigate and promote avenues to attract research into clean coal technology to Texas. In addition, several electric utility companies are working with private research institutions, including universities in Texas, as well as with the U.S. Department of Energy, on research grants to evaluate emissions reduction technology.

Research into the critical issues impeding further coal and lignite use and development, such as new combustion and emission control technology, and commercial development of these technologies, is underway in other parts of the country. Research and development must be expedited at the federal level and within Texas. Texas must work in partnership with the DOE and industry.

Texas has the opportunity to step forward and take a leadership role in these activities. The Clean Coal Technology Council established by the Governor is the logical focus for these

activities. The CCTC should be given an expanded mandate that clearly includes R&D, local, state and federal public education and outreach, support of lignite and coal-fired projects using clean coal technologies, including the development of coal gasification technology, and full support for the President's FutureGen initiative and its siting in Texas.

Summary of current clean coal technology projects in Texas

According to the U.S. Department of Energy, there are currently 19 clean coal research and development projects underway in Texas with a total value of $33.77 million. Texas A&M, the University of Texas, UT – Pan American and Stephen F. Austin University are among the participating academic institutions.

	Number of Projects	Total Value* (Million $)	DOE Share (Million $)	Job Benefits**
Coal & Power Projects	19	$33.77	$22.96	1,351

*Includes DOE and private sector cost-sharing

**An average of 40 direct and indirect jobs per $1 million in R&D funding is used based on the Dept. of Commerce RIMS II formula and a report entitled "Revised United States Job Impacts of the United States DOE Advanced Power Technology Program," January 1998.

Five Texas Universities Studying the Next Generation of Coal and Power System Technologies

Texas A&M University and the Texas Engineering Experiment Station (TEES), College Station, TX, are conducting six projects that are investigating advanced power systems and improved catalysts that will convert coal into liquid fuels. The projects have a combined total value of $1.55 million (DOE share: $1.36 million).

Single-Crystal Turbine Blades - TEES is working on a $443,000 project (DOE share: $354,000) to study the mechanics of single-crystal turbine blades to improve gas turbine efficiency. The project team will develop a model that will analyze lifetime prediction and failure analysis to improve the design and reliability of turbine blade structures for operation at higher temperatures. The capability to operate at higher temperatures will improve the fuel efficiency of gas turbines.

Improved Iron Catalysts for F-T Synthesis - In an entirely DOE-funded $200,000 project, TEES is working with Hampton University to develop iron catalysts that will convert coal-derived synthesis gas into virtually sulfur-free diesel fuels. The catalysts will be designed for the slurry-phase Fischer-Tropsch (F-T) process. This process normally breaks down iron catalysts into fine particles during operation, causing serious operating difficulties in separating the product from the catalyst. The primary objective of this project is to develop catalysts that will resist breaking down during operation while maintaining high activity and the ability to produce clean diesel fuel.

Modeling Flow, Heat Transfer, and Combustion - TEES is developing a model of flow, heat transfer, and combustion in circulating-bed combustors. The model will use the Multi-Phase Flow with Interchange Exchanges (MFIX) computer code, developed at the National Energy Technology Laboratory, to describe the behavior in the circulating-bed combustors. The project has a $323,000 total value (DOE share: $255,000) and will help engineers develop more efficient combustion systems.

Solid State Sensors for Measurement of NOx & Ammonia - TEES is working on a fully-funded $199,000 DOE project to develop new optical sensors for the measurement of nitric oxide (NO) and ammonia (NH3) by optical absorption in combustion exhaust streams. The development of these diode-laser-based systems will enhance pollution emission sensor capabilities for practical combustion devices including coal boilers and power-generating gas turbines.

Development of Direct DC to AC Converters for Solid Oxide Fuel Cells - TEES University researchers are working to develop a new and innovative power converter technology for SOFC power systems meeting SECA objectives. The fuel cell inverter will use state of the art power electronic devices configured in two unique arrangements to achieve direct conversion of DC power (24-48V) available from a SOFC to AC power (120/240V, 60Hz) suitable for utility interface or stand alone loads. The primary objective is to develop a cost effective fuel cell converter that operates under a wide input voltage range and output load swings with high efficiency and improved reliability. The project total value is $188,000 (DOE share: $150,000).

Kinetics of Slurry Phase Fischer-Tropsch Synthesis - TEES has been awarded a fully-funded $200,000 DOE project to develop a comprehensive kinetic model for slurry phase Fischer-Tropsch synthesis on iron catalysts.

The University of Texas at Austin, Austin, TX, has three projects that are developing clean energy technologies for future energy systems. The projects have a combined value of $4.23 million with DOE contributing $3.97 million.

CO_2 Capture Using Potassium Carbonate - University researchers are exploring the possibility of capturing CO_2 by absorption with aqueous potassium carbonate. The project will use prior laboratory results to develop a model to predict the CO_2 absorbing performance of aqueous potassium carbonate. A pilot plant study will be conducted to validate the model and to demonstrate the process. The model will be adjusted according to the results of the pilot plant study. DOE has provided $516,000 of the $782,000 project total.

Determining which Saline Aquifers are Suitable for CO_2 Sequestration - CO_2 sequestration in saline aquifers is maturing from a general concept to one of the most promising options for reducing global warming emissions. Researchers at the University of Texas at Austin are developing and then applying criteria to determine the best saline aquifer candidates for long-term CO_2 sequestration. This is the next step in making CO_2 sequestration a successful component of U.S. emission reduction strategies. DOE is completely funding this $3.25 million project.

Novel Membranes for Hydrogen Separation - Many industrial processes such as petroleum refining would benefit greatly if gas separation membranes were available that could remove impurities from hydrogen streams more efficiently and cost effectively. This research project is developing a new class of polymer/inorganic nanostructured membranes that will remove CO_2 from hydrogen gas streams. These membranes would be the foundation of a new, low-energy process that will concentrate gases such as CO_2 from hydrogen to simultaneously purify hydrogen and concentrate CO_2 for eventual sequestration. DOE has provided full funding for the $200,000 project.

Maximizing Storage Rate and Capacity of CO_2 - Texas Tech University, Lubbock, TX, is conducting a $2.63 million project (DOE share: $2.09 million) that will use nuclear magnetic resonance (NMR) to develop a well-logging technique that will characterize the integrity and quality of geological formations to store CO_2. This technique will be combined with hydraulic fracturing to provide a quicker, more efficient, more cost-effective way to sequester CO_2 in geological formations. If successful, the project may have the capability to permanently sequester CO_2 at a throughput 10 to 50 times greater than allowed by current technology.

Reclaiming Abandoned Mines for Use as Terrestrial Carbon Sinks - Stephen F. Austin State University, Nacogdoches, TX, is working on a project to help DOE achieve its long-term goal of sequestering CO_2 at a cost of $10 per ton or lower. Sequestering CO_2 will help future fossil energy power plants achieve their goal of being nearly pollution free. In this $840,000 project (DOE share: $628,000), university researchers will reclaim and reforest abandoned mine lands in the Appalachian mountain range to sequester CO_2 in trees and vegetation. The project team will evaluate different land and forest management techniques to maximize CO_2 sequestration and to bring these abandoned sites back to productiveness. Reclaiming and reforesting abandoned mines will also provide the added benefits of protecting wildlife habitat, increasing recreational opportunities, enhancing soil productivity, controlling soil erosion, and improving water quality.

Simulation of a Natural Gas Burner - The University of Texas-Pan American, Edinburg, TX, is conducting a $60,000 project (DOE share: $20,000) that will simulate a natural gas swirl burner and investigate its effects on temperature and pollutant emissions. The goal of the project is to obtain the optimal burner operating conditions. The project results will lead to a more efficient and environmentally superior burner design.

Simulation/Modeling of a Low-Emission Swirl-Cascade Burner - The University of Texas-Pan American, Edinburg, TX, is conducting a second burner simulation project valued at $35,000 (DOE share: $20,000) that will develop a simple, low-cost burner technology that would significantly reduce emission of pollutants without energy efficiency penalty. The project will use CFD-CHEMKIN simulation modeling to numerically investigate the effects of key variables on the combustion and emission characteristics and obtain optimal performance for swirl-cascade burner technology.

Companies Developing Co-Production Plants, Emissions Controls, Filtration Systems and Advanced Materials

Early Entrance Co-Production Plant - Texaco Energy Systems Inc., Houston, TX, is conducting a $14.29 million project ($8.80 million from DOE) to develop a power plant that would be capable of co-producing electric power and fuels or chemicals. The process will use coal and other carbon-based feedstock to produce synthesis gas. The facility will be located at the Motiva Port Arthur Refinery in Port Arthur, TX. Co-production of multiple products could become a lower cost and more efficient way to use fossil fuels because it combines feedstock flexibility with product flexibility while providing environmentally superior performance

Controlling Sulfuric Acid Emissions with Alkaline Furnace Injections - The URS Group (formerly Radian International), Austin, TX, is conducting a full-scale demonstration of a technology for removing sulfuric acid from the flue gas of coal-fired electric utility boilers. The technology injects alkaline materials into the boiler furnace to capture the sulfuric acid. This cost-effective approach is one of the most promising near-term solutions for reducing sulfuric acid emissions. Reductions are necessary because sulfuric acid can damage the catalyst in selective catalytic reduction (SCR) systems, one of the technologies likely to be required for NOx control, especially in many Eastern states where NOx emissions cause smog and other air quality problems. Removing the sulfuric acid compounds also reduces a variety of plant operating and maintenance problems and can reduce the formation of fine particulate matter (PM2.5) in the atmosphere. DOE is providing $1.16 million of the $3.08 million project value.

Testing of Mercury Oxidation Catalysts - In a second project, The URS Group is evaluating catalysts in flue gas, downstream from the particulate removal device, to determine their effectiveness in oxidizing elemental mercury. Oxidized mercury is easier to capture than elemental mercury. The goal of the $1.19 million project (DOE share: $898,000) is to develop a catalyst with a life of three years while maintaining oxidation efficiency greater than 90 percent.

Evaluation of a Cyclone and Hot Gas Filter System - Gasification Engineering Corporation, Houston, TX, was awarded a $750,000 (DOE share: $600,000) project to evaluate the design and economic benefits of a hot gas hybrid cyclone-filter dry particulate removal system over hot gas filtration systems. The reduced solids loading by use of a cyclone should allow a smaller hot gas filtration system, which would help increase system availability and lower the installed cost, operating cost, and maintenance costs for the next generation of hot gas particulate removal systems.

Ferritic Interconnect Materials for Solid-Oxide Fuel Cells - Southwest Research Institute, San Antonio, TX, was awarded a $187,000 (DOE share: $150,000) project to demonstrate performance of heat-resistant Ferritic stainless steel containing aluminum and yttrium. The performance will also be demonstrated in a hydrogen/water vapor atmosphere in contact with an anode material. Several types of surface modifications will be carried out to render the alumina scale robust and electronically conducting. Cation diffusion will be investigated as a

factor determining cell life and area surface resistance (ASR) measurements shall be taken as anode- and cathode-interconnect couples are exposed to representative temperature and atmospheric conditions.

Wabash River Integrated Methanol and Power Production from Clean Coal Technologies - Gasification Engineering Corporation, Houston, TX, was awarded a $4.92 million (DOE share: $3.27 million) project for the three phase development of a plant producing methanol and electric power from gasification of coal and other carbonaceous feedstocks entitled "Integrated Methanol and Power Production from Clean Coal Technologies" (IMPPCCT). The objectives of Phase I are to determine the feasibility, define the concept for the site specific IMPPCCT and to develop a Research, Development, and Test Plan (RD&T Plan) for implementation in Phase II. The objective of Phase II is to conduct the RD&T outlined in Phase I to enhance the development and commercial acceptance of coproduction technology. The objective of Phase III is to develop an engineering design package and a financing plan for an IMPPCCT located at a specific site. The project's intended result is to provide the necessary technical, economic, and environmental information that will be needed to move the IMPPCCT forward to detailed design, construction and operation by industry. If successful, the project will lead to a preliminary design package for a coproduction facility that produces clean electricity and methanol for sale.

4. FUTUREGEN

FutureGen

FutureGen is a $1 billion partnership between the U.S. government and private industry to design, build and operate a nearly emission-free, coal-based electric and hydrogen production plant. The prototype project will be the cleanest fossil-fuel based power plant in the world.

Proposed by President Bush a little more than a year ago – and now in the initial stages of U.S. Department of Energy (DOE) funding – the 10-year FutureGen project will be an international test facility for breakthrough technologies, including coal gasification technology.

In addition to the scientific achievement of producing coal-based energy in a virtually emissions-free environment, FutureGen will capture and permanently store carbon dioxide. Sequestration can occur geologically, including opportunities to utilize it for enhanced oil and gas recovery, and terrestrially through living organisms such as trees. DOE says FutureGen is the first-of-its-kind project by the electric power production industry to demonstrate that large-scale carbon dioxide (CO_2) sequestration is safe and practicable.

Additionally, FutureGen – based on a coal gasification process – will be the first coal-to-gas plant in the world configured to optimize hydrogen production while simultaneously sequestering carbon dioxide. The hydrogen will be used as a clean fuel for electric power generation, or with recombined gas products it could be supplied as a feedstock for refineries, chemical plants, fertilizer plants, or used as a transportation fuel.

FutureGen will also have the opportunity to develop revenue streams from coal components recovered in solid form. Specifically, these will be slag and sulfur. Leading slag applications are blasting grit, roofing shingle granules, and snow and ice control. Slag has also been used as an aggregate in asphalt paving, as a structural fill, and in road base and subbase applications. The sulfur produced from the gasification portion of FutureGen will be near elemental and available for use in a variety of applications by the chemical industry.

FutureGen represents a significant research step toward proving the feasibility of near zero-emission, coal-fueled electric power generation and the potential energy, environmental and energy security benefits it promises are far-reaching.

TEXAS MEETS DOE'S FUTUREGEN OBJECTIVES

Texas is a natural fit for Future Gen. It is unrivaled among competitor states from the scientific/geological perspective regarding sequestration and commercial use of carbon dioxide.

Texas is unmatched in providing a market for all of FutureGen's byproducts, which include: electricity, CO_2, and hydrogen, among others.

Texas has a ready source of coal and lignite to fuel FutureGen, the right geology for CO_2 sequestration, a transmission grid for carrying the increased power load, the technical expertise to make FutureGen a reality, and a skilled workforce capable of making the most of increased energy production opportunities.

Texas meets each of DOE's expressed objectives for FutureGen.

GEOLOGY

The natural, geological formations in Texas are ideal for the sequestration of carbon dioxide.

- Two major carbon sequestration projects – the Frio Brine Project and the Gulf Coast Carbon Center – are being conducted in Texas. The results of these collaborative projects will apply directly to FutureGen and offer a method to make sequestration economically successful.

- The Texas Commission on Environmental Quality (TCEQ) is on record in support of technological advances to meet Texas' air quality challenges, and it welcomes FutureGen as an opportunity to develop cutting-edge technology that will further reduce emissions and ensure energy independence.

ENHANCED OIL RECOVERY (EOR)

CO_2 sequestration is essential for FutureGen to achieve emissions. One way to make sequestration economically viable is to link captured CO_2 with oil reserves, producing increased recovery efficiencies of those petroleum resources and more jobs.

Texas has the largest EOR potential in the United States, which can create long-term value for FutureGen.

- Texas is the world leader in EOR. The first CO_2 flood occurred in 1972 in West Texas, and this area remains the world leader in terms of this technology. The 50 CO_2 EOR projects active in West Texas represent about 50 percent of total CO_2 flooding activity worldwide.

- CO_2 EOR regulatory experience is deep in Texas; it is one of the only states in the nation set up to permit the CO_2 process.

- The knowledge base for this technology is well developed in Texas with more than 40 years of CO_2 EOR experience and more than 11,000 wells permitted for CO_2 injection in the state.

- In an April, 2004, study "CO_2-Enhanced Oil Recovery Resource Potential in Texas," UT's Bureau of Economic Geology identifies at least 31 billion barrels of oil in Texas that are recoverable using CO_2-driven EOR.

- EOR projects become economically viable at these price points: $1/mcf of CO_2, $27 per barrel of oil.

DEMOGRAPHICS

Texas' demographics, business climate and regulatory structure make it an ideal testing ground to demonstrate the feasibility of FutureGen and its energy, research, commercial and environmental applications.

- Texas' growing population, surging commercial activity, and reliance on coal-based electricity will provide the ideal marketplace for FutureGen-produced electricity and, at the same time, provide a textbook test ground for the effectiveness of the project's environmental applications.

- The state's abundance of chemical refineries presents a ready market for FutureGen-produced hydrogen and other byproducts, other potential coal-based chemicals, and the feedstocks for electric power generation.

- The increased energy demands of population centers such as Houston, Dallas, Fort Worth, Austin and San Antonio, coupled with available markets for FutureGen's byproducts greatly improve the opportunities for the project to ultimately prove profitable.

RESEARCH AND DEVELOPMENT

Texas is recognized globally as a leader in clean coal research and the development of power system technologies.

There are currently 33 clean coal research and development projects under way in Texas with a total value of at least $33.77 million, according to the U.S. Department of Energy, with funding shared by DOE and the private sector. Project participants include universities, research centers and private industry.

Texas public universities and private institutions have a long history of world-class leadership in energy and environmental research that will address all significant aspects of FutureGen, including:

- Research in coal processing, including generation of synthesis gas and the conversion of synthesis gas to hydrogen and other valuable products.

- Material research for reforming coal at high temperatures.

- Gas purification and recovery research, including: capture of CO_2, removal of sulfur and nitrogen oxides, absorption of mercury, and membrane-based recovery of hydrogen.

- The University of Texas' Bureau of Economic Geology and Texas A&M University's Center for Energy and Mineral Resources are acknowledged leaders in energy research and technology development.

- The Texas Energy Center, a public-private sector effort, seeks to accelerate development of cutting-edge clean energy technologies by private companies, research institutes, universities and governments, and up to $10 million may be available to fund a FutureGen-related technology team.

- Texas universities include leading academics in issues related to socioeconomics, business, public policy, and other topics important to the success of FutureGen.

ECONOMIC IMPACT

Energy resources have historically been one of the most important underlying factors in the growth and economic development of Texas.

The Governor and Lieutenant Governor of Texas and the Speaker of the Texas House of Representatives – the state's highest ranking elected officials – are in strong support of FutureGen, recognizing that the project will continue Texas' leadership in energy production and energy technology development.

- The $1 billion FutureGen project could create as many as 40,000 jobs in Texas. This is based on the finding that an average of 40 direct and indirect jobs are created for every $1 million in research and development funding, according to the U.S. Commerce Department RIMS II formula and a report entitled "Revised Unites State Job Impacts of he United States DOE Advanced Power Technology Program," January 1998.

- The building of FutureGen will require hundreds of construction workers and up to 500 employees for full plant operation, according to Southern Illinois University projections. Industry experts project that could include around 200 jobs for the integrated gasification combined cycle (IGCC) portion of the project, with the other R&D jobs based on the specific requirements of FutureGen.

- Coal-based electric generation and coal mining in Texas are responsible for $10.5 billion annually in total expenditures, 33,000 permanent jobs and $330 million in state and local revenue, according to the Perryman Group.

- Successful demonstration of FutureGen's gasification technology will open additional opportunities in Texas for production of power, chemicals, fuels, hydrogen, and fertilizers from coal, petroleum coke, biomass, and other feedstocks.

- FutureGen's testing of lignite as a utility fuel is essential for the project to meet its design goal of broadening the number of power plant configurations and coal types available for energy production.

- The direct economic benefits to Texas of recovering 31 billion barrels of oil from fields that are suitable for CO_2 flooding are staggering. Based on $25 per barrel oil, the economic value is:

    - 50 percent recovery (15.5 billion barrels) – wellhead value, $338 billion; severance tax $18 billion; ad valorem taxes, $15 billion; jobs created, 7.4 million; economic value, $1.1 billion; franchise tax, $2 billion, and sales tax, $23 billion.

    - 100 percent recovery (31 billion barrels) – wellhead value, $775 billion; severance tax, $36 billion, ad valorem taxes, $31 billion; jobs created, 14.8 million; economic value, $2.25 billion; franchise tax, $4.1 billion; and sales tax, $45 billion.

CONCLUSION

SUPPORT/OUTREACH

Texans are rapidly uniting in support of FutureGen as details of this important project become more widely known. As you will see from the attachments, Texas leaders in the energy and research fields have joined with elected officials during the past year to form a statewide base of support for FutureGen. CCTC members are committed to building on that success through an aggressive outreach/educational campaign that continues to generate support for the state's proposal to bring FutureGen to Texas.

- The Council has identified as a priority the siting and development of FutureGen in Texas.

- The Foundation is asking for the support of the Texas Legislature and the state's congressional delegation in working to bring this project to Texas, including the passage of necessary legislation.

- Briefings have been provided to members of Congress, White House and DOE officials, members of the Texas Legislature, and statewide business organizations of the state's FutureGen efforts.

5. Additional Recommendations

In order to promote affordable electric generation for Texas consumers, the Clean Coal Technology Council (CCTC) additionally recommends the following:

1. Position Texas to be the primary center for research and deployment of clean coal technology, including FutureGen and coal gasification, led by the CCTC:
    a. Create regulatory standards and review processes that support the deployment of new technologies, especially during research trials and pilot projects.
    b. Provide incentives to promote the use of clean coal technology such as:
        i. Incentives could be used to help underwrite installation of control and other clean coal technologies in new and existing facilities;
        ii. Encouraging bundled electric utility investment in clean coal technology:
            a. the Public Utility Commission of Texas (PUCT) should provide timely recovery of investments in clean coal technology,
            b. the Public Utility Regulatory Act (PURA) should be amended to ensure recovery of any stranded costs should these utilities move in to retail competition,
            c. the PURA should be amended to streamline the certification process, and
        iii. Treating energy developed utilizing clean coal technologies, specifically including gasification, as "clean fuels" equal to natural gas, LNG and other clean fuels.

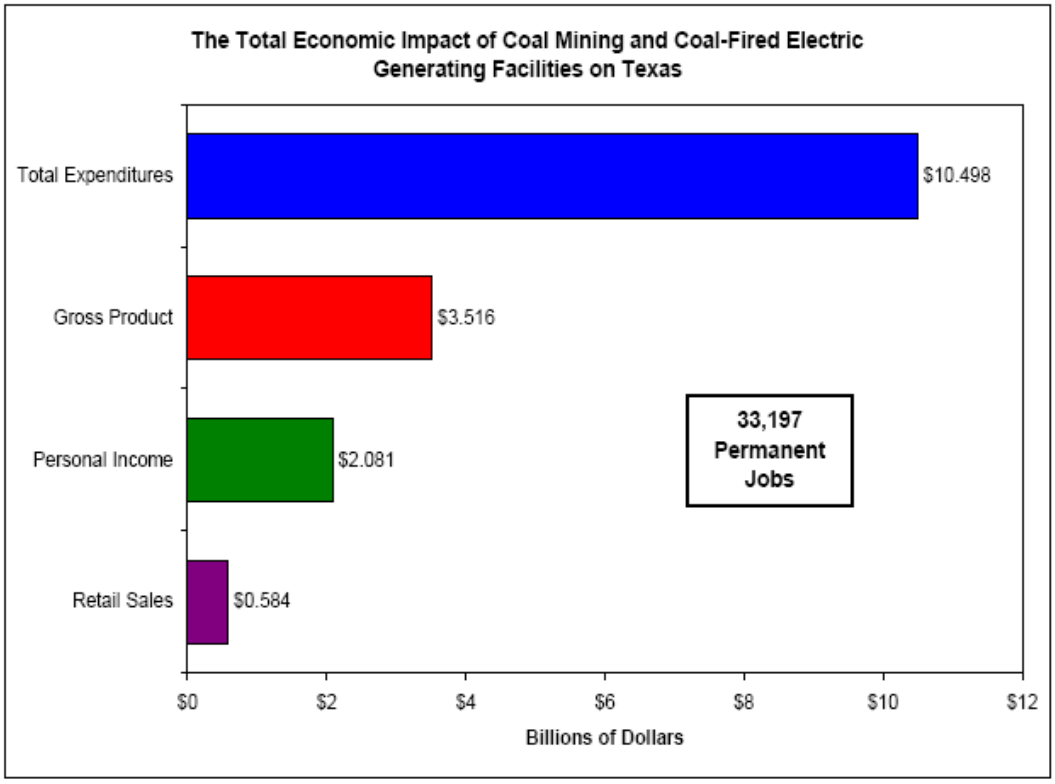
2. Texas must aggressively pursue the siting and development of FutureGen in Texas.
    a. Pass during the 2005 Session of the Texas Legislature a package of legislative and financial incentives that supports the siting of FutureGen in Texas.
    b. Mobilize Texas' political leaders and prepare and submit to the U.S. Department of Energy (DOE) a proposal to site FutureGen in Texas. This collaborative effort should include the Governor's Office, CCTC, Texas Energy Planning Council, Texas federal and state lawmakers, oil and gas industry, chemical industry, pipeline companies and, where appropriate, other states.
    c. Texas should recognize the efforts of the national energy consortium that has pledged $200 million to the FutureGen project and work with this group.
    d Outreach efforts begun by the CCTC should be continued and include members of Congress, members of the Texas Legislature, and federal and state regulatory officials.
    e. Making use of resources such as the University of Texas Bureau of Economic Geology, and Texas A&M University's Center for Energy and Mineral Resources, research should be continued and expanded that bolsters Texas' position that it is the natural fit for FutureGen.

3. Focus on low-cost, reliable electricity and ensure the fuel mix to achieve this:
    a. Consider the cost per Btu when setting goals for fuels for electricity.
    b. Carefully review proposed funding recommendations regarding the various fuel types to ensure that all costs are identified and considered.

4. Ensure that the Texas lignite and coal industry will remain economically viable during the transition from existing technology to gasification and other clean coal technologies:
    a. Support efforts to phase-in attainable Federal air regulations that match sound science and technology.
    b. Maintain the tax or fee rates on the production or use of Texas lignite or coal at the current rates with no new taxes or increased fees.
    c. Consider re-evaluation of state and federal emission reduction requirements so maximum allowable credit is given for emission reductions already obtained before requiring further reductions from the same industry sources.
    d. Improve access to rail transportation by alleviating obstacles to the siting and development of new track and spurs.

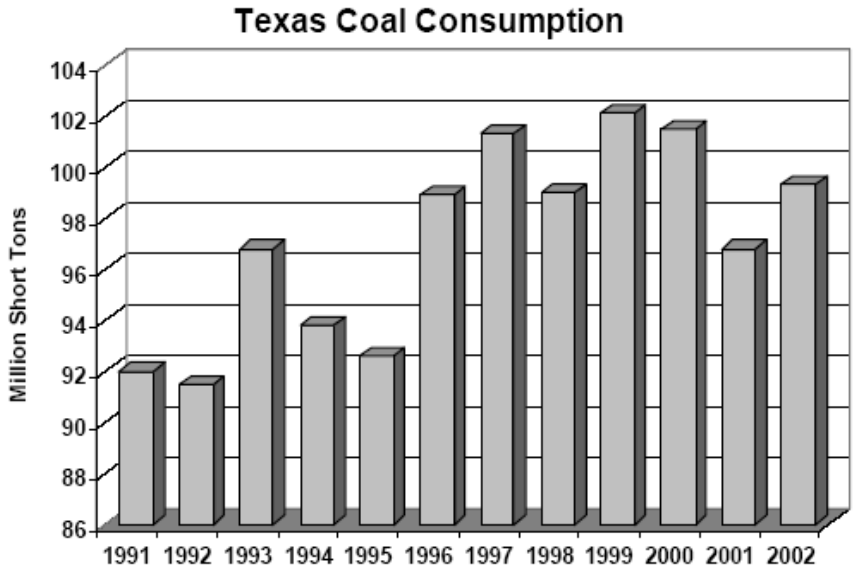
6. Charts and Graphs

Figure 1.



Source: The Perryman Group, The Economic Impact of Coal Mining and Coal-fired Electric Generation Activity on Texas and the East Texas Region, 2004

Figure 2.



Source: Texas Energy Planning Council, 2004

Figure 3.

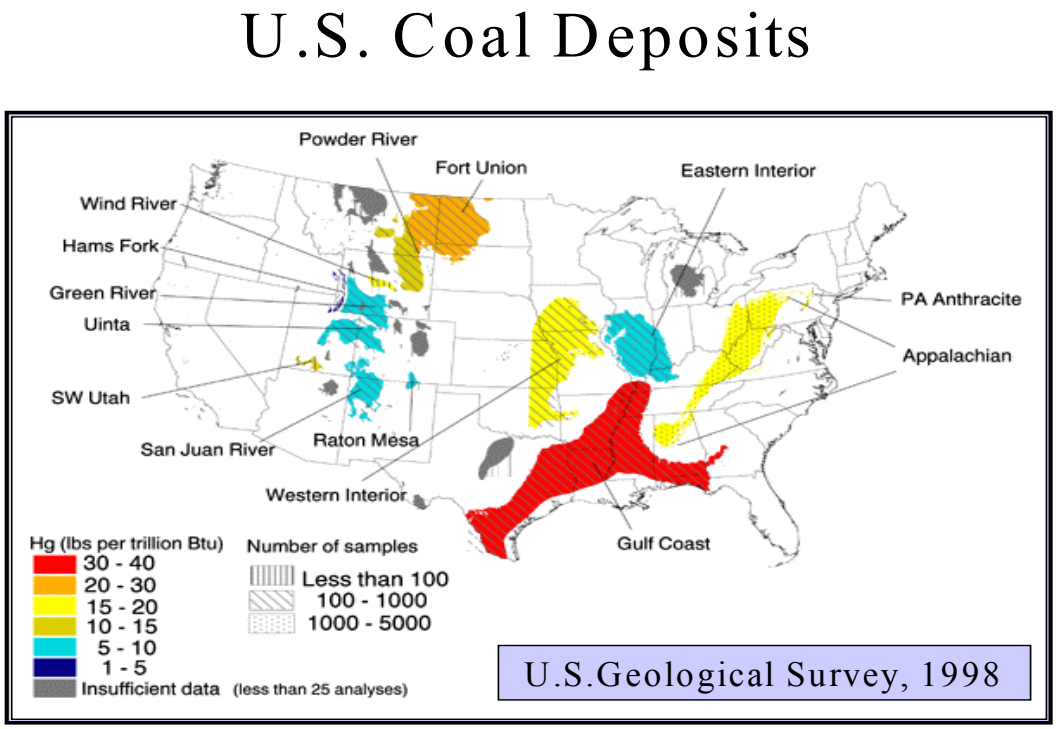
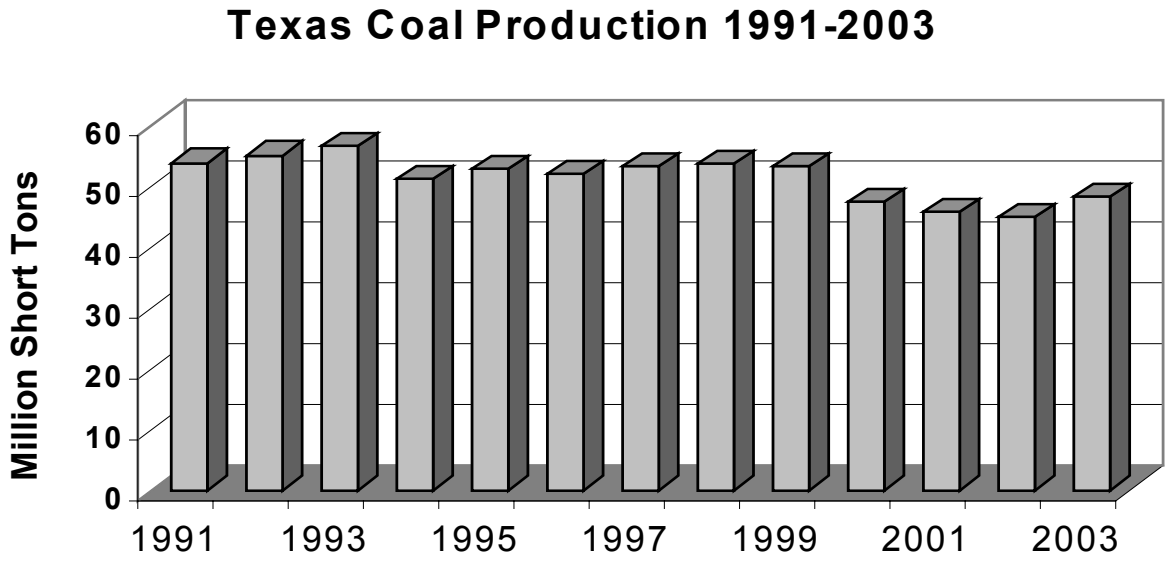


Figure 4.



Source: RRC; Texas Energy Planning Council, 2004

Figure 5.

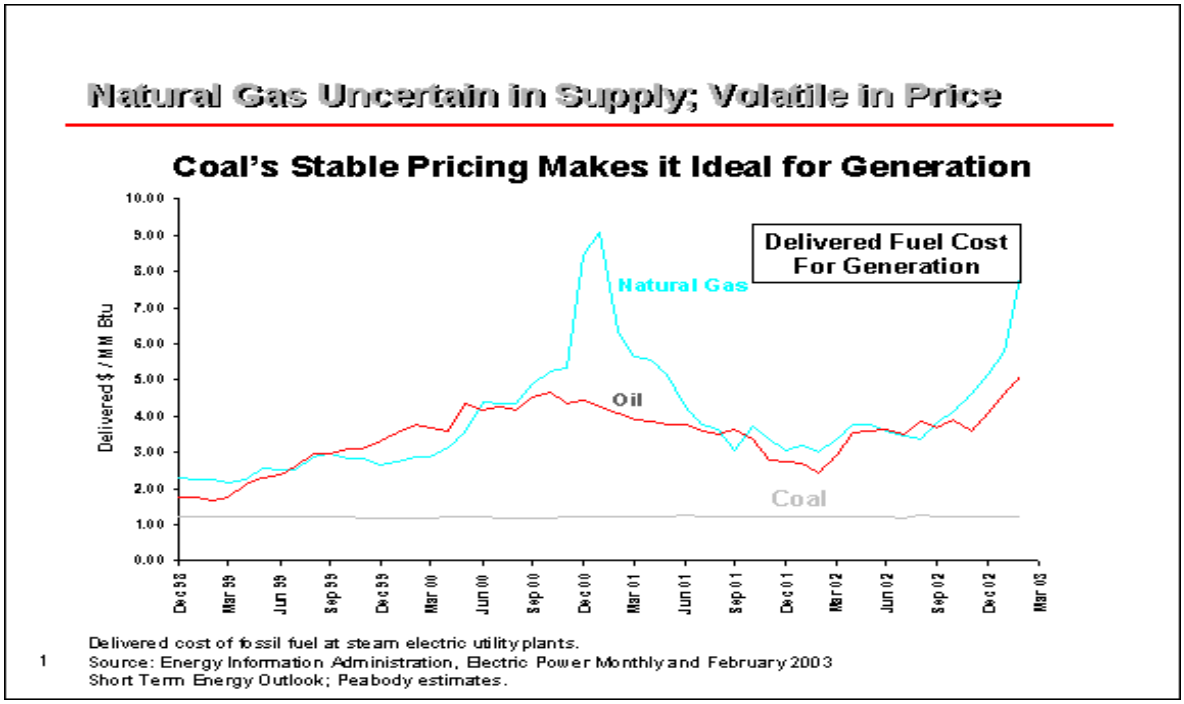
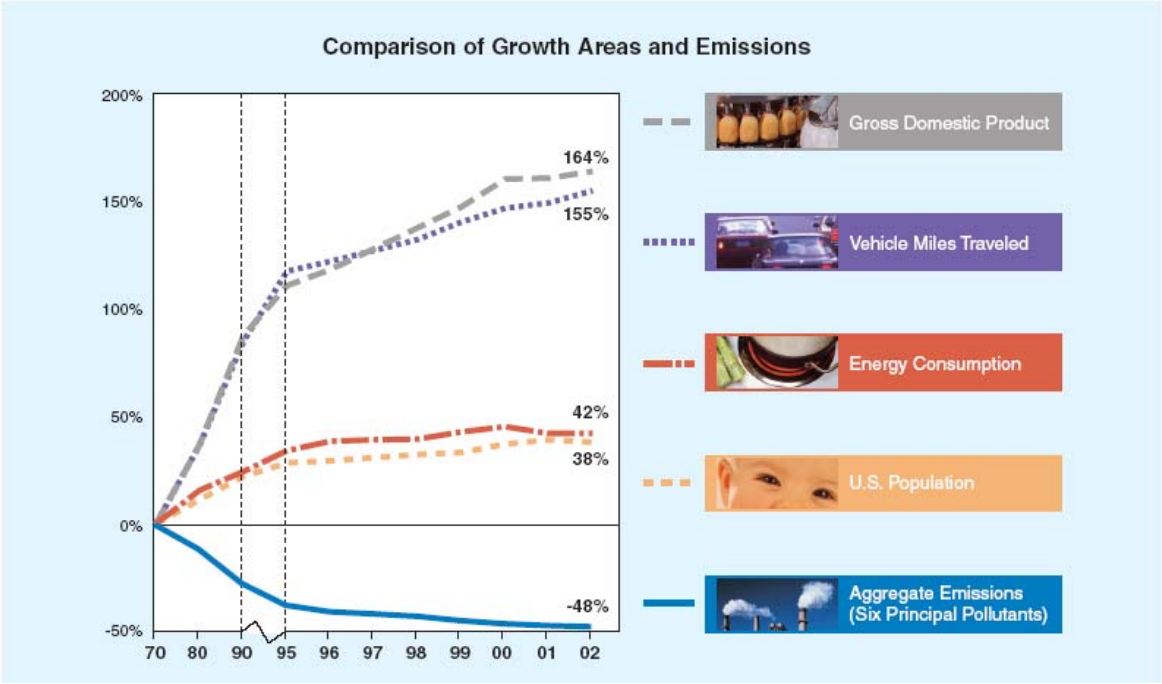


Figure 6.



Section III

Attachments

Attachment A
Governor's Executive Order

Attachment B
Articles of Incorporation
Clean Coal Technology Foundation

Attachment C
Bringing FutureGen to Texas
Report to the Clean Coal Technology Council